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SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Blinding
2. Raft Foundation
3. Suspended Slabs.
4. Building frame members (beams, columns, etc…).
5. Building walls (Shear walls, core walls, walls parapets, etc…).
6. Retaining walls
7. Stairs
8. Technical block
9. External stairs

1.3 PERFORMANCE REQUIREMENTS

A. Structural Design: The Contractor shall carry out his own calculations and working drawings conforming to the information given below. The Contractor shall check and verify the following parameters for concrete design, and if there are any conflicts, he shall inform the Engineer as soon as possible and get approval before modifying anything.

B. The structural design is based on the Lebanese Code. If this code gives no guidance for case under consideration the following international codes of practice and standards, shall be used:

1. Dynamic design
    a. Seismic: UBC 1997 (Uniform Building Code)
    b. Wind: The basic dynamic wind pressure shall be considered as given by an approved International Meteorology Service; (100 mile/hour).
2. Reinforced concrete structures:
    a. ACI 318M-08 (Building code requirements for reinforced concrete).
    b. ACI 224.3R-95 Joints in Concrete Construction.
    c. ACI 350-01 (American Concrete Institute for the design of water retaining structure).

d. UBC 1997.

e. ASCE 7-05.

3. Steel Structures:

a. AISC, LRFD load and resistance factor design, 13th edition 2005.

4. Design Loads:

a. ASCE 7-05 (minimum Design loads for building for buildings and other structures).

b. ANSI (American National Standards Institute)

c. UBC 1997, volume 2, Chapter 16.

d. ACI 318-08.

e. AISC 360-05.

5. Design of all buildings structures shall be based on the ultimate strength design method in accordance with the applicable codes previously listed. A serviceability check on cracks and deformation of service loads shall be made.

6. Any structural design carried out by the Contractor shall conform to these standards unless otherwise instructed by the Engineer.

C. Seismic Data:

1. Seismic Zone: 2B.

2. Seismic zone factor: 0.25 g in accordance with Lebanese regulations.

3. Soil type: SC.

4. Seismic coefficients Ca: 0.29; Cv: 0.39

5. Importance factor equal to 1.25 (essential building: surgery & emergency treatment area)

6. Strength reduction factor R: 5.5

D. Bearing capacity and soil (The Contractor shall take all measures and procedures to verify the below mentioned values including soil testing investigation, soil treatment, etc…)

1. The allowable bearing capacity under vertical loads has been taken equal to 2.75Kg/cm² (gravity design)

2. The allowable bearing capacity under vertical loads has been taken equal to 3.5Kg/cm² (seismic design)

3. Depth of foundation equal to 1.5 m

4. The coefficient of subgrade Reaction equal to 4000t/m³.

5. The lateral Earth Pressure due to backfill. If exists behind external retaining walls, should have the following parameters:

a. Soil unit weight: 2.1 t/m³.

b. Angle of internal friction: 35°

6. Technical area: equipment load to be calculated

E. Loadings (Live Load)

1. Covering Tiles = 250 kg/m2 for slabs
2. Internal Partition = 220 kg/m2 of wall (TH=12cm)
3. Internal Partition = 270 kg/m2 of wall (TH=15cm)
4. External Partition = 410 kg/m2 of wall (TH=22cm)
5. Live Load = 250 kg/m2
6. Roof Live Load = 100 kg/m2
7. Snow Load on roof = 120 kg/m2
8. Water Load on roof = 100 kg/m2
9. Water Load on staircase = 650 kg/m2 (40m3)

F. Live load on roads (retaining wall design) = 2t/m².

G. Live load on paved concrete for pedestrian: 0.5t/m².

H. Temperature variation: ± 20°C.

I. Design members such that thickness and concrete cover over reinforcement comply with the following hours fire-resistance requirements:

1. All vertical structures (walls and columns) and all horizontal transfer structures supporting walls or columns have been designed to achieve 2 hours fire resistance
2. All other horizontal structures (beams and floor slabs) have been designed to achieve 2 hours fire resistance
3. This is in accordance with the ACI 216.1-8.

J. Fire Break: Structures shall be designed according to prescriptions and norms for structure security and stability, given the function of each room. Fire-resistance and subsequent security measures (fire-break cladding, wall, etc.), should abide by ministerial decrees and specifications.

1. Levels in buildings shall be separated by 2-hours fire-break slabs.
2. Structures bearing those areas shall have respectively the same fire-break limits.
3. Where construction joints connect two different areas, these shall be filled with an anti-fire material, so to assure the stability of fire-break structures within the required time limits.

K. Concrete retaining walls supported by slabs or beams should not be backfilled until all propping elements are cast and have gained the design strength.

1.4 SUBMITTALS

A. General: All submittals to the approval of the Engineer.

B. Product Data: For each type of product indicated.

C. The Contractor shall submit to the engineer complete calculation notes, 3D modeling, seismic model, design analysis of all structural elements and information for concrete works.

D. The contractor shall submit to the engineer a complete method statement and materials submittal with detailed specification compliance sheet, for his approval.

E. Soil Investigation Report: The Contractor shall take all measures and procedures to verify the allowable soil bearing capacity values listed in the General Notes and Typical Details drawing and shall submit soil investigation report and method of soil treatment if necessary. The Contractor shall notify the Engineer in the event the investigation indicates significant variation from the values of the bearing capacity, angle of internal friction, etc,… listed in the above mentioned drawing, In the case dimensions, sections, and reinforcement of the foundation shall be revised accordingly at the Contractor's expenses on the basis of revised calculations to the approval of the Engineer..

F. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

G. Execution, Shop and Coordination Drawings, Calculation Notes and Seismic Model: Submit in a format approved by the Engineer, with full details to the satisfaction of the Engineer to assist him in his approval.

H. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Bending dimensions for scheduling of bars for the reinforcement shall be in accordance with BS 8666 and BS EN ISO37666.

I. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing material fabrication, assembly, and support of formwork.

J. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.

K. Admixtures: Submit to the Engineer the admixtures intended to be used in the Concrete mix for his approval.

L. Samples: For the types of product indicated.

M. Welding certificates.

N. Qualification Data: For Installer, manufacturer and testing agency.

O. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements for the following tests:

1. Aggregates: main tests needed are: Sieve Analysis (ASTM C136), Determination of Acid chloride and sulfate (BS EN 1744), Los Angeles Abrasion (ASTM C131), Determination of clay lumps (ASTM C142), Density & Specific gravity & Absorption (ASTM C128 & C127), Sand Equivalent (ASTM D2419), Bulk density & unit weight (ASTM C29), Organic impurities (ASTM C40), Soundness of aggregates (ASTM C88), in addition to a combined grading test for aggregates (crushed sand + natural sand + medium aggregates + coarse aggregates) including grading curves, and others upon engineer's request
2. Cement: detailed chemical analysis & physical tests (initial setting + final setting + surface area), upon engineer's request

3. Water: Main tests required are: Chemical Analysis of water mainly PH testing (ASTM D 1293), Sulfate testing (ASTM D 516), Chloride testing (ASTM D 512),Total dissolved Solids, and others upon engineer's request.
4. Steel reinforcement: Main tests required are: Tensile Strength (ASTM A 370), Bending strength (ASTM A 370), chemical analysis test, and others upon engineer's request.

P. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Floor and slab treatments.
8. Bonding agents.
9. Adhesives.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

Q. Submit technical sheet of the couplers for approval.

R. Floor surface flatness and levelness measurements to confirm compliance with specified tolerances.

S. Field quality-control test and inspection reports.

T. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, and approved by the Engineer.

C. Concrete finishes, unless otherwise specified:
1. Smooth finish: apply to all concrete surfaces, unless otherwise specified.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete."
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

H. Acceptance tests: All materials, goods and products which are going to be used or introduced into the works shall be tested before delivery to the site to prove that they comply with the quality requirements. The compliance of the acceptance tests has to be approved by the Engineer.

I. Routine tests: After the approval, all materials, goods and products need continuous quality control by routine testing after different intervals, if not exempted by the Engineer.

J. Additional tests: Additional tests which are not mentioned in this specification may be required by the Engineer, have to be carried out according to the standard test procedures if not mentioned by the Engineer.

K. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

1. Build panel approximately (18 sq. m) for slab-on-grade and (9 sq. m) for formed surface in the location indicated or, if not indicated, as directed by the Engineer.
2. Approved panels may become part of the completed Work if undisturbed at time of Substantial Completion.

L. Tolerances: according to BS 5606 or ACI 117.

M. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Preliminaries.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    c. Contractor's superintendent.
    d. Ready-mix concrete manufacturer.
    e. Concrete subcontractor.
2. Review special inspection and testing procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. All reinforcement shall be stored on racks clear of the ground.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Ready-Mixed Concrete: Transport and deliver concrete according to ASTM C 94/C 94M and BS 5328, and furnish batch ticket information.

D. When air temperature is between 30 and 32 deg C, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 32 deg C, reduce mixing and delivery time to 60 minutes.

E. Cements: obtain from an approved source. Cement shall be delivered in sealed and branded containers in batches not exceeding 100 tons or in purpose-made bulk delivery vehicle. Store all cement in suitable weatherproof and approve storage sheds which protect the cement from dampness. The consignment of cement as received shall be separately stored and used in order of delivery. Do not use cement manufactured more than twelve months prior to propose use on the site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

B. Products: Subject to compliance with requirements, provide one of the products specified.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

D. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

A. Fairface Finished Concrete:

1. This type of surface finish denotes a special finish required from aesthetic considerations. In additions to the requirements of smooth formed finished concrete (as mentioned below) the following additional requirements shall apply.

   a. Produce fair-face finish with impervious sheet material (e.g. plastics faced plywood/steel sheet)

   b. The formwork shall leave no stain on the concrete and shall be so joined and fixed to its backing so that it imparts no blemishes. It shall be of the same type and obtained from only one source for any one structure. Furnish in largest practicable sizes to minimize number of joints.

   c. No gravel or rough sand pockets to be visible at the surface. Surfaces shall be free from voids, honey-combing, fins, projections and other defects

d. Internal ties and embedded metal parts shall not be permitted unless otherwise approved by the Engineer.

e. Do not use concrete cover spacers without approval.

f. It is of major importance that the special finishes required on fairface surfaces are uniformly and consistently maintained with no variation in the color or consistency of the concrete within the same structure.

g. In order to achieve this, the Contractor shall make trial panels of the formed finishes specified. These panels shall be not less than 1.5 m high and 1 m wide and 250 mm thick and shall be cast in the manner and with materials as proposed for the actual Work. These panels are for the approval of the liners and are preliminary to the test samples carried out on site.

h. The Contractor shall provide at his own expense as many panels as required by the Engineer until a satisfactory trial panel has been accepted by the Engineer. In addition, the Engineer will require samples of exposed faces to be cast on site in the same manner as proposed for the prototypes. The Contractor shall submit to the Engineer and obtain his approval for all details before commencement of trials. These samples, when approved, will form the standard against which the corresponding finishes on the actual work will be judged.

i. If the required finish in the opinion of the Engineer, has not been obtained in the Works, the Contractor shall promptly carry out at his own expense all measures required by the Engineer to obtain the specified finish. Where remedial action is ordered by the Engineer, the entire exposed surface shall be so treated irrespective of whether or not the defective areas are localized or extensive.

j. Forms for circular, cylindrical and curved columns and walls, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, or fiber tubes that will produce fairfaced surfaces. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

B. Smooth-Formed Finished Concrete:

1. Plywood, metal, or other approved panel materials.

2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. High-density overlay, Class 1 or better.

b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.

c. Structural 1, B-B or better; mill oiled and edge sealed.

d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

3. Form-facing panels that will provide continuous and smooth concrete surfaces of uniform appearance. Surfaces shall be free from voids, honey-combing, fins, projections and other defects.

C. Sides of footings shall be cast directly into the excavation walls, unless otherwise directed by the Engineer.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, (20 by 20 mm), minimum wherever required.

E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than (25 mm) to the plane of exposed concrete surface.

2. Furnish ties that, when removed, will leave holes no larger than (25 mm) in diameter in concrete surface.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars designed by (T): High tensile steel conforming to ASTM-A 615M, Grade 60, deformed, fy =4200 Kg/cm².

B. All reinforcing steel bars designated by (Ø) should have a minimum yield strength of f/y=3,000 kg/cm²

C. Low-Alloy-Steel Reinforcement Bars: ASTM A706, deformed when welding is required.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

E. Reinforcement hook details, lap splices, development length and concrete cover should be done according to the ACI318-08 code except indicated in the drawings.

F. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

G. Reinforcement weight/m as published in the BS4449 shall be used for calculating reinforcement quantities.

2.4 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Spacers shall be of such materials and design as will be dense durable, not lead to corrosion of the reinforcement, and not cause spalling of the concrete cover. Spacer blocks made from cement, sand and small aggregates shall match the mix proportions and appearance of the surrounding concrete and shall have cylinder compressive strength, durability of not less than the surrounding concrete. They shall accordingly support the reinforcement, resist displacement, not cause indentation of the formwork.

1. Spacers will not be permitted against a concrete face which will be exposed in the finished works.

2. Concrete spacer blocks made on Site are not permitted.

B. COUPLERS

1. Couplers shall comply with BS 8110 when used with reinforcement bar.

2. Standard tapered thread coupler to join the reinforcing bars. It comprises an internally threaded sleeve with two right hand threads tapered toward the middle of the coupler.

3. Installation:

   a. Supply coupler fixed to one of the corresponding reinforcing bar.

   b. Position the continuation bar in the sleeve and rotate the bar into the coupler

   c. Tighten the joint to the specified torque using a wrench on the continuation bar.

4. Coupler dimension shall be as per the following table:

Bar diameter	**12**	**16**	**20**	**25**	**32**	**40**	**50**
External diameter (d)	22	25	30	36	46	55	70
Coupler length (l)	58	70	74	90	112	138	170
Weight (kg)	0.09	0.17	0.26	0.43	0.86	1.42	2.22
Torque (Nm)	60	110	165	265	285	330	350

5. Manufacturer: Lenton by Erico, or approved equal.

2.5 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Cement for concrete for all structures in contact with soil /water should be Ordinary Portland cement type I with silica fume, cement for other structures should be Ordinary Portland Cement: ASTM C 150, Type I.

2. Rapid hardening portends cement and cement with a low heat of hydration should only be used where specified on the project documents or by the Engineer.

3. High Alumina Cement: is prohibited

4. Ready mix concrete should be used, placed in the forms and compacted using mechanical vibrators within a period of not more than 40 minutes in ordinary weather and 30 minutes in hot weather.

5. Fresh concrete should not be subjected to any disturbance, vibration or rain water until it harden enough.

6. Fresh concrete must be kept wet and cured with potable water for not less than 7 days. Any other curing compound can be used after the approval of the engineer.

7. All underground concrete surfaces should be well water proofed and protected.

8. All hardened slabs and beams must be remained partially propped during construction in order to carry the weight of the above unhardened slab supported on it.

9. Unless otherwise noted, the bottom side of the beam forms should be given a camber of:

   a. span/500 for beam span > 5m

   b. span/200 for cantilevers.

10. In the case of ordinary loading and normal temperature, concrete forms cannot be removed before:

    a. 2 days for columns and walls.

    b. 2x(span+2) days for slabs and beams but not less than14 days.

B. Normal-Weight Aggregates: ASTM C 33, for “Severe Weathering Region” hard durable carefully graded to the requirements of ASTM C 33. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: (20 mm) free of material causing staining or reacting with cement and with less than 5% magnesium, sulfate soundness loss.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement obtained from natural sand.
3. All sand shall be screened and washed. Beach sand is not allowed.

C. Lightweight aggregates:

1. The lightweight aggregates shall be composed predominately of lightweight cellular and granular inorganic material.

D. For structural concrete: Unless otherwise specified, foamed or expanded blast furnace slag to BS 877 or to ASTM C330. The unit weight of successive shipments of lightweight aggregates shall not differ from sample submitted for acceptance tests by more than 10%.

E. For insulating concrete: Unless otherwise specified, the lightweight aggregates for insulating concrete shall comply in all respects with ASTM C332

F. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

A. Suitable admixtures may be used only if approved by the Engineer. Both proposed dosage and method of use shall be submitted to the Engineer.

B. Certificate: The following information shall be submitted to the Engineer concerning any admixture proposed for use:

1. Brand name, manufacturer’s name and address with manufacturer’s recommendations for the admixture.
2. Typical dosage and detrimental effects of under-dosage and over-dosage.
3. Chemical names of the main active ingredients in the admixtures.
4. Whether admixture contains chlorides or not. If present, the chloride content should be expressed as a percentage of equivalent anhydrous calcium chloride by weight of admixture.

C. Whether or not admixture leads to air entertainment when used at the manufacturers recommended dosage.

D. Standards: Tests for quality control on the main types of admixtures shall be carried out according to ASTM C494 and ASTM C260 respectively.

E. Trial mix: Before approving any admixture, the Engineer shall require tests to be carried out. These shall be done by trial mixes and compared with concrete of the same class but containing no admixture (control mix) to determine the effects of the admixture especially regarding workability, setting time, and density.

F. Admixtures should not impair the durability of the concrete nor combine with the ingredients to form harmful compounds nor increase the risk of corrosion of the reinforcement.

G. No deviation from the approved sources of colouring agents shall be allowed by the Engineer or by the Owner.

H. Pulverized fuel ash shall not be permitted and should not be used for sulphate resisting concrete.

I. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Air-Entraining admixture: ASTM C 260.
2. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
3. Retarding Admixture: ASTM C 494/C 494M, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

J. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

K. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

L. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

1. Color: As selected and approved by the Engineer.

2.7 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Profile: Surface type ribbed with central bulb at expansion joint and ribbed without center bulb at construction joint.
2. Dimensions: 225 mm by 10 mm thick; nontapered, unless otherwise specified.

2.8 FLOOR AND SLAB TREATMENTS (where slabs are exposed)

A. Emery Dry-Shake Floor Hardener: factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

B. Color: As selected by the Engineer from manufacturer's full range.

C. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

2.9 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 305 g/sq. m when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.10 RELATED MATERIALS

A. Polythene sheet under slab on grade:

1. ASTM D 4397, 0.025 mm thick, clear
2. Should have a water vapor performance of 0.016 grain/hr.ft².in.Hg in accordance with ASTM E 96 and should be approved by the Engineer.

B. Expansion and Isolation Joint Fillers: Extruded-Polystyrene Board Insulation, ASTM C 578, of type IV. Joints shall agree with the structural requirements, having the following technical characteristics:

1. Minimum density should be 32-35 kg/m3.
2. Minimum compressive strength = 300 KPa
3. Water Absorption: 1 % by Volume.
4. Flammability: Class B1, as per DIN 4102.
5. Thermal Conductivity: 0.032 W/mK
6. Widths and thicknesses: as shown on drawings and details
7. Approved Manufacturer: Carlisle or approved equal

C. Fire Resistant Joint fillers, as per Engineer' request.Heavy duty Board glue: of type as required by the engineer.

D. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

E. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, non-load bearing and IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

F. All bolts, washers, nuts and threads shall conform to BS 4190 Gr. 4.6 or ASTM A325 when diameter is less than 16mm and to BS 3692 Gr. 8.8 and 10.9 or ASTM A490 when diameter is greater than 16mm.

G. Reglets: Fabricate reglets of not less than (0.55-mm-) thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

H. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

I. All embedded steel components shall be hot dip galvanized steel in accordance with ASTM A123 or ASTM A153 as appropriate of grade 50 unless otherwise specified.

2.11 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 3.2 mm and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 3.2 to 6 mm or coarse sand as recommended by underlayment manufacturer.
4. Cylinder compressive Strength: Not less than 350 Kg/cm² at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from (3 mm) and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 3 to 6 mm or coarse sand as recommended by topping manufacturer.

4. Cylinder compressive Strength: Not less than 350 Kg/cm² at 28 days when tested according to ASTM C 109/C 109M.

2.12 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

C. Evidence of suitability : For each mix submit, in writing, details of:

1. Proposed quantities of each ingredient per cubic meter of compacted concrete,
2. Evidence showing that proposed constituent materials and method of manufacturing will produce concrete of required quality.

D. Approval: Do not use mixes before submitted information and evidences have been approved. This approval is not however sufficient by itself and will not interfere or influence other requirements pertaining to mixes' compliance with due specifications.

E. Color control: Obtain approval before altering proportions or grading of concrete exposed in finished work.

F. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

G. Total sulphate content in concrete mix arising from constituents and other sources shall not exceed 0.4% by weight of aggregates or 4.0% by weight of cement in mix.

H. Admixtures: Use admixtures according to manufacturer's written instructions and as per section 2.6.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion normal-weight concrete mixture.

B. The Contractor shall submit for approval concrete mix designs for each class of concrete to be used in the works. The design parameters of these mixes are set out in paragraph "2" below. The concrete compressive strength is defined in terms of the 28 day characteristic strength for 15x30 standard cylinder. The compressive strengths listed below are the design compressive strengths. The average of all cylinder crushing strengths obtained on site for each of the sections of the Project shall exceed the required design characteristics strength f'c as recommended by concrete conformity procedures in British Standards whichever is higher.

1. Water / Cement Ratio:
   a. Maximum Water-Cementitious materials Ratio as follows:

      Foundation and tie beams Maximum W/C: 0.38.

      Columns and walls Max. W/C: 0.38

      Retaining walls Max. W/C: 0.38

Slabs and beams Max. W/C: 0.38

Lean concrete Max. W/C: 0.5

2. Classes of Concrete

a. Columns, walls, shear walls
f'c = 30 MPa

b. Retaining walls
f'c = 30 MPa

c. Slab on grade (pavement)
f'c = 25 MPa.

d. Blinding and cyclopean concrete
f'c = 15 MPa.

Where f'c is the compressive strength on cylinder 15x30cm after 28 days.

3. Minimum Cement Content

a. For structural concrete f'c = 30 MPa , the minimum cement content shall be 400 Kg/m³.

b. For structural concrete f'c = 25 MPa , the minimum cement content shall be 350 Kg/m³.

c. For Lean concrete/cyclopean concrete f'c = 20MPa, the minimum cement content shall be 250 Kg/m³.

a. Concrete for screed shall have a minimum cement content of 250 Kg/m³.

4. Basis of Design

a. The Contract design has been produced on the basis of a design compressive strength on cylinder at 28 days.

b. The inter-relation between cube 15x15x15cm versus cylinder 15x30cm strength of concrete will be based upon the BS 8500-1, 2002,table A.20 and BS EN 206-1 if directed by the Engineer.

C. All vertical structures (walls and columns) and all horizontal transfer structures supporting walls or columns have been designed to achieve 2 hours fire resistance. All other horizontal structures (beams and floor slabs) have been designed to achieve 2 hours fire resistance. This is in accordance with the ACI 216.1-8.

D. All concrete are to be normal weight (2500 Kg/m³), well compacted and in accordance with the specification.

2.14 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.15 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information. Each load shall be

accompanied by a delivery note stamped with the time of mixing and stating the concrete grade and quantities of each material including water additives.

1. When air temperature is between (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above (32 deg C), reduce mixing and delivery time to 60 minutes.

B. In situ Mixing on Site: Not allowed under any circumstances, unless specifically authorized by the Engineer.

2.16 Testing and Approval of Constituent Materials

A. Preliminary tests and samples: tests and samples shall be provided and approved before making and placing concrete unless otherwise specified.

B. Samples of natural aggregates: submit preliminary samples to ASTM or BS standards of aggregates proposed for concrete work.

C. Preliminary tests on natural aggregates: obtain preliminary tests to ASTM or BS standards for:

1. Sieve analysis
2. Clay, silt and fine dust
3. Specific gravity
4. Water absorption
5. Bulk density, voids and bulking
6. Moisture content
7. Organic impurities
8. Aggregate impact value
9. Aggregate crushing value
10. 10% fines value
11. Crushing strength
12. Aggregate abrasion value
13. Chemical properties (soluble salt contents).
14. Obtain tests on every consignment from a new source and additional tests required by the Engineer.

D. Test certificates for cement: provide manufacturer’s test certificates and obtain approval before starting trial mixes. Obtain manufacturer’s test certificates every 28 days during the progress of the work and retain on the site.

E. Tests on cement: representative samples from a minimum of ten bags from each batch shall be obtained and tested in accord with the requirements of BS 12, BS 4027 or ASTM C150 depending on the type of cement. Batches and consignments which do not fulfill the required cement quality tests shall not be used in the work and shall be removed immediately from the site.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork to concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, (3 mm) for smooth-formed finished surfaces with no finishes.
2. Class B, (6 mm) for rough-formed finished surfaces intended to receive plaster or stucco.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

M. The Contractor should provide a workshop to repair the defective formwork on site. The re-use of formwork is depending on the resulting finish quality and according to the Engineer for approval.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Embedded items shall be provided in due time for installation, without delaying the progress of the work.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3. Install dovetail anchor slots in concrete structures as indicated.

B. The Contractor shall refer to mechanical and electrical drawings for verification of openings, pipes and sleeves (location, size, levels…) in the reinforced concrete structural members. No openings, pipes or sleeves other than indicated on structural drawings shall be placed without the approval of the Engineer.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place for at least 21 days.

2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Engineer.

3.4 SHORES AND RESHORES

A. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.

B. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

C. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

D. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4 only, where indicated and allowed by the Engineer.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Unless otherwise noted, splice lengths shall be as follows:

1. 60 x Bar diameter for beams, slabs, walls, columns and footings. No splice shall be made at places not indicated on drawings without the approval of the Engineer.

G. Reinforcement shall not be in contact with pipework.

H. Bending dimensions for scheduling of bars for the reinforcement shall be in accordance with BS 8666 and BS EN ISO 3766.

I. All reinforcement details shall be in accordance with ACI 318 for in-situ and cast reinforced concrete. In addition, all reinforcement detail shall be in accordance with the recommendations of the ACI 315-29 details and detailing of the concrete reinforcement.

J. Unless otherwise shown on drawings, the minimum concrete protective cover for reinforcement shall be as follows:

1. For slabs, flat beams and walls not exposed to earth or weather: 2 cm
2. For fair faced concrete elements exposed to weather: 5.0 cm
3. For drop beams and columns: 4.0 cm
4. For basement walls and ground beams: Outside face: 5.0 cm Inside face: 2.5 cm
5. For footings: 7.5 cm if exposed and 5cm if not.
6. For all surfaces in contact with water or vapor: 7.5 cm
7. For earth retaining walls: Exposed to earth: 5.0 cm Exposed to weather: 5.0 cm

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Joints shall be located between areas having different loads.

C. Joints shall have class I movement capability.

D. Joints shall agree with the structural requirements.

E. All Expansion joints shall be fire resistive complying with UL 2079 with a fire-resistance rating not less than the rating of adjacent construction (2 or 3 hours as specified).

F. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least (38 mm) into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Approval from the design Engineer shall be obtained for the location of any construction joints not shown on the plans.

G. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least 1cm, unless otherwise specified as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. The Contractor shall propose and submit a detailed layout for contraction joints to be approved by the Engineer prior to any execution works.
2. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of (3 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

H. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 13 mm or more than 25 mm below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.7 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Engineer.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
4. Under condition of rain, the placing of concrete shall not commence or shall be stopped unless adequate protection is provided to prevent damages to the surface mortar, or damaging flow, or wash of the Concrete surface.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

4. Under condition of rain, the placing of concrete shall not commence or shall be stopped unless adequate protection is provided to prevent damage to the surface mortar, or damaging flow, or wash of the concrete surface.

F. Hot-Weather Placement: Comply with ACI 301 and/or BS 8110 clause 6.2.5, and as follows:

1. Maintain concrete temperature below (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3. On exposed concrete surface in high sun temperatures and/or strong drying wind conditions, the Contractor shall use a curing method which also shields the concrete and this shall be placed in position no later than half an hour after final tamping. If the surface exhibits cracking while the concrete is still plastic then it shall be re-tamped to close the cracks.

4. No Concrete shall be placed whilst the shade temperature is above the requirements of ACI 301. The Contractor shall supply an accurate maximum and minimum thermometer and hang it in an approved position in the works.

G. Foundations shall be supported on original stiff strata. In case foundations must be supported on fill, cyclopean concrete or proper compaction shall be performed according to Engineer instruction and approval.

3.9 FINISHING FORMED SURFACES

A. General: Comply with ACI 301 and ACI 347 requirements for finishing formed surfaces.

B. Fair-faced Finish: Where remedial action is ordered by the Engineer, the entire exposed surface shall be so treated irrespective of whether or not the defective areas are localized or extensive.

1. Apply to all concrete surfaces as indicated on Drawings.

C. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed herein specified limits on formed-surface irregularities.

1. Apply to concrete surfaces as indicated on Drawings.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.

1. Apply scratch finish to surfaces indicated to receive concrete floor toppings and to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with thin-film-finish coating system.

2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, (3-m-) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed (3.2 mm)

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with (300-mm) lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 REMOVAL OF FORMWORK AND FALSEWORK

A. In determining the time for the removal of forms, consideration shall be given to the location and character of the structure, weather and other conditions influencing the setting of the concrete.

B. Formwork shall be removed in a manner not to damage the concrete, and at times to suit the requirements for its curing and to prevent restraint that may arise from elastic shortening, shrinkage or creep.

C. For ordinary structural concrete made with ordinary Portland cement only, the period before striking shall be in accordance with the minimum periods given in Table below, unless otherwise directed by the Engineer.

D. Minimum Period Before Striking for Ordinary Structural Concrete Made With Ordinary Cement:

Type of Formwork	Minimum Period Before Striking Surface Temperature of Concrete		
	16C	7C	tC
Vertical formwork to columns, walls and Large beams	24 hours	36 hours	600 hrs / t + 10
Soffit formwork to slabs	6 days	9 days	150 days / t + 10
Props to slabs	10 days	15 days	250 days / t + 10
Soffit to formwork to beams	9 days	14 days	230 days / t + 10
Props to beams	14 days	21 days	360 days / t + 10

3.14 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 28 days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by the Engineer. Remove and replace concrete that cannot be repaired and patched to the Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than (13 mm) in any dimension in solid concrete, but not less than (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to the Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to the Engineer's approval.

3.16 FIELD QUALITY CONTROL

A. Samples: To ensure adequate quality control of mixes on the site, take samples per type of concrete such as (slab on grade, walls, beams, columns, etc…) of each concrete mix from every mixing point in accordance with the recommendations of BS 8110 and the requirements of BS 1881 or in accordance with ACI 318-89 Part 3, Chapter 4.

B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding (4 cu. m), but less than (20 cu. m), plus one set for each additional (38 cu. m) or fraction thereof.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is (4.4 deg C) and below and when (27 deg C) and above, and one test for each composite sample.
5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C 31/C 31M.
   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

b. Cast and field cure sets of two standard cylinder specimens for each composite sample.

7. Cylinder compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.

b. A cylinder compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive cylinder compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

10. Test results shall be reported in writing to the Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer but will not be used as sole basis for approval or rejection of concrete.

12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by the Engineer.

13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

14. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing.

SECTION 033100 - CAST-IN-PLACE MASSIVE CONCRETE

PART 1 - **GENERAL**

1.1 SUMMARY

A. This Section specifies cast-in place of massive concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Raft Foundation
2. Massive Column
3. Thick Slab

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Massive Cast-in-place concrete is any slab, raft or wall with thickness equal or larger than 0.8 m

1.3 REFERENCES

A. Refer to section 033000

1.4 DEFINITIONS

A. Refer to section 033000

1.5 SUBMITTALS

A. All items in section 033000

1.6 QUALITY ASSURANCE

A. All items in section 033000

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to section 033000

PART 2 - **PRODUCTS**

2.1 MANUFACTURERS

A. Refer to section 033000

2.2 FORM-FACING MATERIALS

A. Refer to section 033000

2.3 STEEL REINFORCEMENT

A. Refer to section 033000

2.4 REINFORCEMENT ACCESSORIES

A. Refer to section 033000

2.5 CONCRETE MATERIALS

A. Cementitious Material: Use the same items as per section 033000 in addition to the following requirements

1. Portland Cement:
   a. Cement Type III or a combination of cementing materials meeting the requirements of rapid hardening Portland cement shall not be used
   b. Use one brand of cement throughout the Project unless otherwise approved by Engineer. Manufacturer's test certification shall be supplied for each delivery of cement and shall confirm that the cement complies with the above requirements and shall be submitted by the Contractor not later than the day of delivery of the cement. The Engineer shall have the right to call for tests, the cost of which is to be borne by the Contractor, on each delivery of cement to confirm that the cement meets the following requirements.
   c. Hot (newly produced) Cement is not allowed to be used
   d. Cement and cementing materials used in the concrete mixture shall produce low heat generation.

B. Normal-Weight Aggregates: Refer to section 033000
1. Preferable to use limestone aggregates
2. High fines in crushed manufactured aggregates is not allowed.
3. Shrinkage of concrete shall be tested and meet 400 to maximum 500 micro-strain

C. Water: Refer to section 033000

2.6 ADMIXTURES

A. Refer to section 033000
1. Accelerating admixture shall not be used
2. Admixture containing chloride is prohibited

2.7 CURING MATERIALS

A. Refer to section 033000
   1. The curing of concrete shall be by water ponding

2.8 REPAIR MATERIALS

A. Refer to section 033000

2.9 CONCRETE MIXTURES, GENERAL

A. Design mixes to provide normal weight concrete with the properties in accordance with that stated in Section 33000.

B. Water-Cement Ratio: The free water-cement ratio shall not exceed the values specified in 33000. The water-cement ratio shall be continuously checked at the mixer with due allowance made for water contained in the aggregates. Under no circumstance shall water be added between the mixer and the place of concrete placement. The Engineer may require that the water-cement ratio be checked during tests performed on fresh concrete samples taken at the time of placement.

C. The initial setting time shall not be less than Two hours after the concrete is discharged into the form.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised mix design and strength results shall be submitted to and approved by Engineer before using in the Work.

E. One mock-up of minimum dimensions 2m x 2m x 2.5m (or thickness of structural member whichever is greater), shall be prepared for each trial mix for the purpose of measuring the temperature variation inside the concrete by thermocouples as detailed in section 3.1 below.

F. Sample preparation, test procedure, and results shall be submitted for Engineer approval.

PART 3 - **EXECUTION**

3.1 GENERAL

All the requirements indicated in part 3 Section 33000 shall be applied. Additionally, the below specification shall be considered as mandatory:

A. At least two months before commencement of concreting, the Contractor shall submit a method statement for temperature control. The information to be submitted shall include, but not be limited to, the following:

   1. Concrete mix details including heat of hydration and specific heat characteristics of the cementitious constituents, expected concrete temperature rise and the proposed initial concrete placing temperature;
   2. Formwork type and insulation;
   3. Curing details related to temperature effects;

4. Maximum and minimum concrete placing temperatures;
5. Minimum and maximum times before formwork is stripped;
6. Any additional methods for controlling the concrete temperature;
7. Concrete temperature monitoring proposals which shall be sufficient to demonstrate that the requirements of the Contract will be met;
8. Analyses and calculations to prove that the proposals will meet the requirements of the Contract

B. The contractor shall provide an evaluation with a field test mockup reflecting the temperature rise in concrete.
   1. The test shall consist of an insulated 2m x 2m x 2.5m (thickness of structural member) concrete block constructed to the approval of the engineer.
   2. The block shall be instrumented with a minimum of three centrally located thermocouples connected to an automatic data logger and hourly readings shall be taken until the temperature has fallen to more than 25ºC below the peak temperature.
   3. The concrete block shall be constructed and instrumented to the approval of the engineer. The construction and monitoring of thermocouple shall be witnessed by the material inspector and the engineer.
   4. The concrete blocks shall be retained for a minimum of 3 months or as directed by the engineer in a manner to ensure that damage or degradation will not occur.
   5. The results of this test shall be used in conjunction with the Contractor's proposed insulation/cooling methods to evaluate compliance with the temperature control requirements.

C. Temperature control for concrete shall comply with the following requirements:
   1. The Contractor shall employ effective means such as shading the aggregates, precooling mixing water and adding flaked ice to ensure the temperature of concrete prior to and including the time at which it is placed shall not exceed 25ºC unless otherwise demonstrated by the mockup test and approved by the Engineer.
   2. After the concrete has been placed, its peak temperature in any part of the structure shall not be permitted to rise above 70ºC, unless otherwise approved by the engineer.
   3. After the concrete has been placed, the maximum temperature difference between a point at the center of a concrete section and the adjacent surface shall not be greater than 20ºC
   4. The Contractor shall employ effective means such as insulation, water insulation, selection of appropriate pour cycle times, or heating/cooling as necessary, to ensure that at any time within 21 days after the concrete has been placed, the temperature differential between any point in the freshly placed concrete of any structural element at a distance of 300mm from a construction joint and the corresponding point 300mm from the construction joint in the adjacent previously placed structural element, shall not exceed 20°C.

D. Concrete Temperature Measurement
   1. The Contractor shall continuously compare the real time results of the ongoing temperature monitoring with the predicted values and make appropriate adjustments to the temperature control methods used on current and subsequent pours to ensure compliance with the Specification.

E. The temperature of the hydrating concrete shall be measured for each pour until 21 days after pouring using a sufficient number of calibrated thermocouples to demonstrate that the maximum hardened concrete temperature and differential temperature have been achieved, within ± 2 °C

F. Accuracy
   1. The thermocouples shall be suitably robust to withstand concrete placing, and be adequately protected and firmly fixed in position on the reinforcement cage. The thermocouples shall not be placed closer than 400 mm to any cooling water pipes to ensure that they give representative temperature readings
   2. The output of the thermocouples shall be continuously recorded using an automated data logger. The power supply to the data logger shall not be interrupted and the equipment shall be maintained and checked at least twice per day to ensure that they are operating satisfactorily.
   3. The thermocouples shall be calibrated in conjunction with the working and backup data logger(s) and the calibration results shall be submitted at least 7 days prior to incorporation within the Works.

4. After installation of the thermocouples within the element and immediately prior to concreting, the thermocouples shall be checked by comparing the relative ambient temperature readings. Any damaged or malfunctioning thermocouple shall be replaced prior to the commencement of concreting.
5. After the placing of concrete, the temperature readings shall be taken at a maximum of hourly intervals for the initial 7 days after placing. The monitoring frequency can be reduced to 12 ±1 hours thereafter until 21 days after placing or until the maximum temperature is less than 15 °C above the daily minimum ambient temperature.
6. The output from the data loggers shall be downloaded daily by the Contractor. A copy of the data shall be given to the Engineer immediately after downloading in an agreed electronic and hard copy format.
7. Within 7 days from the completion of the temperature monitoring period the contractor shall submit a report. The report shall include the individual tabulated temperature results and calculated values indicating compliance, as required by the Specification, for all maximum and differential temperature measurements. The report shall be presented in both tabulated and graphical format and shall include all thermocouples within the same measurement plane on the same graph to ensure that the temperature differential between the core, surface and ambient is readily discernible. Any non-compliance with the Specification shall be highlighted and proposals given for remedial works and ensuring compliance in subsequent pours.

G. Special measures

If the Contractor proposes to place the reinforced massive concrete structure in more than one operation, he shall demonstrate to the satisfaction that:

1. The temperature differential limits at all stages will not be exceeded at any one time;
2. The maximum temperature of 70 °C will not be exceeded;
3. The stresses in the concrete structure due to temperature changes under strain will not induce tension cracks;
4. The construction joint will be treated to ensure monolithic action between the different pours.

H. When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Contractor is responsible for ensuring these limitations in the variation of temperature in the concrete. These limitations shall be verified by conducting a theoretical simulation prior to placement. It shall take into consideration all the expected conditions during the casting process to ensure that the previously indicated temperature constraints will be satisfied.
2. Cover reinforcing steel with water-soaked burlap so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
4. Use water-reducing retarding admixture when required due to high temperatures, low humidity, or other adverse placing conditions, as acceptable by the Engineer. Use of flaked ice, chilled water as a replacement of water by weight.
5. Shade mixing plant and trucks, aggregates, water tanks, and cement silos.
6. Paint the mixing plant, trucks, water tank, and cement silo with sunray reflecting colors.
7. Insulate the water tank and supply piping.
8. Provide necessary shades over and around the concrete being poured to prevent sun rays from coming into direct contact with the surface of the concrete and the formwork for a period of about 7 days (minimum from the time of pouring concrete).
9. Concrete placing shall be completed as quickly as possible to reduce transit time.
10. Curing of exported concrete shall be immediately carried out.

I. If concrete cast fails to satisfy temperature variation limitations or maximum concrete temperature, the concrete shall be deemed defective and not complying with temperature limitations and may be demolished upon the request of the engineer.

END OF SECTION 033000

SECTION 033816 - POST-TENSIONED CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Furnishing post-tensioning reinforcement and accessories including prestressing tendons, pocket formers, support bars, bar chairs, and slab bolsters.
2. Installing post-tensioning tendons.
3. Performing post-tensioning operations including stressing and finishing tendons.
4. Recording tendon elongations and gage pressures.
5. Finishing tendon ends and patching stressing pockets.
6. Grouting around tendons.

B. Related Sections include the following:

7. Division 3 Section "Cast-in-Place Concrete" for cast-in-place concrete, steel reinforcement, placement of nonprestressed steel reinforcement, and concrete strength testing of laboratory- and field-cured cylinders.

1.3 DEFINITIONS

A. Strand Tail: Excess strand length extending past the anchorage device.

B. Stressing Blockout: Opening created in the slab to allow access to stressing-end anchorages.

C. Stressing Pocket: Void formed by pocket former at stressing-end anchorage to provide required cover over wedges and strand tail.

D. Wedge Cavity: Cone-shaped hole in anchorage device designed to hold the wedges that anchor the strand.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design cast-in-place, post-tensioned concrete reinforcement as indicated in this Section. Show final effective forces, tendon profiles, and nonprestressed reinforcement on design Shop Drawings. All prestressing and workmanship, materials, procedures and equipments shall be in accordance with BS 8110-97(class - 3), ACI 318M-05, UBC – 1997.

B. Design structure to withstand the loads listed in “Section 033000”.

C. Comply with above standards limits on stresses at transfer of prestress and under service load.

D. Comply with above standards requirements for minimum bonded reinforcement.

E. Comply with above standards requirements for concrete cover over reinforcement.

F. Design members such that thickness and concrete cover over reinforcement comply with the following hours fire-resistance requirements:

1. All vertical structures (walls and columns) and all horizontal transfer structures supporting walls or columns have been designed to achieve 3 hours fire resistance.
2. All other horizontal structures (beams and floor slabs) have been designed to achieve 2 hours fire resistance.
3. This is in accordance with the ACI 216.1-8.

G. Deflection Limits Including Creep and Shrinkage Effects:

4. Total Dead Plus Live Load: L/600.

H. Load cases and combinations:

5. Strength load combinations: the strength requirement for each member is established using the following factored load combinations:
   a. To resist dead load (DL) and Live load (LL):

      U = 1.20DL + 1.60LL +1.00 Secondary
6. Where secondary consists of the secondary moments, shears and reactions due to post tensioning.
7. Servicibility load combinations:
   a. Load conmbination for in service stress check:

      U = 1.00DL + 1.00LL + 1.00 Prestressing
   b. Load combination for long-term deflection due to creep and the instantaneous action of live load:

      U = 2.5DL + 0.75LL + 2.50Prestressing
   c. Load combination for checking deflection at immediate:

      U = 1.00DL + 1.00Prestressing
   d. Initial stresses (Transfer):

      U = 1.00selfweight + 1.15Prestressing
8. For the slabs and beams the maximum deflections are maintained below:

Member	Total Long-Term*	Incremental**
Slabs	L/350	L/600
Beams	L/350	L/600

* Due to self-weight and superimposed dead load, creep, shrinkage, and prestressing.

** Deflection after installation of finishes and partitions.

L = length of clear span

1.5 SUBMITTALS

A. Product Data: For the following:

1. Tendon sheathing.
2. Anchorage devices.
3. Tendon couplers.
4. Bar and tendon supports.
5. Pocket formers.
6. Stressing-pocket patching material.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

C. Prepare detailed design of post-tensioned slabs with calculation notes including seismic loads.

D. Submit Design Shop Drawings and full structural design calculations to the Engineer for review. Comply with design intent, criteria, and requirements of the Contract Documents.

E. Shop Drawings: Installation drawings including plans, elevations, sections, details, and notes prepared by or under the supervision of a registered professional engineer detailing tendon layout and installation procedures, including the following:

1. Numbers, arrangement, and designation of post-tensioning tendons.
2. Tendon profiles and method of tendon support including chair heights and locations. Show tendon profiles at sufficient scale to clearly indicate all support points, with their associated heights.
3. The mild reinforcing reqiured over and above the post tensioning tendons, at all locations on the slab.
4. Construction joint locations, pour sequence, anchorage detail, locations of anchorages and blockouts required for stressing.
5. Stressing procedures and jacking force to result in final effective forces used in determining number of tendons required.
6. Sealed calculations prepared by a registered structural engineer indicating method of elongation calculation including values used for friction coefficients, anchorage seating loss, elastic shortening, creep, relaxation, and shrinkage.
7. Calculated elongations for each tendon.
8. Details for horizontal curvature around openings and at anchorages.
9. Details for corners and other locations where tendon layouts may conflict with one another or nonprestressed reinforcing steel.
10. Diagrams and notes as necessary for positioning of nonprestressed reinforcement required for installing post-tensioning tendons including, but not limited to, the following:
    a. Support bars.
    b. Backup bars and hairpins at anchorages.
    c. Hairpins at locations of horizontal curvature.
    d. Supplemental reinforcement at blockouts.

F. Design Shop Drawings and calculations.

G. Product Certificates:

11. For each type of anchorage device and coupler, signed by product manufacturer.

H. Qualification Data: For Installer. Include resume of individual supervising installation and stressing of post-tensioning tendons.

I. Mill Test Reports: Certified mill test reports for prestressing strand used on Project indicating that strand is low-relaxation and including the following:

J. Coil numbers or identification.

K. Breaking load.

L. Load at 1 percent extension.

M. Elongation at failure.

N. Modulus of elasticity.

O. Diameter and net area of strand.

P. Field quality-control test reports.

Q. A copy of the manufacturer's test certificates covering each coil to be used shall be supplied to the engineer. If test certificates relating to the material cannot be supplied, the contractor shall arrange for testing of samples in accordance with CP 115. The cost of this testing shall be borne by the contractor.

R. Even for cases where test certificates are supplied, the engineer may require the contractor to supply one test sample representative of each batch. Testing of these samples will be carried out at an approved laboratory at no cost to the contract.

S. Procedures Statement: Procedures for all post tensioning process including for cutting excess strand tail and patching stressing pocket.

T. Stressing Jack Calibration: Calibration certificates for jacks and gages to be used on Project. Calibrate each jack-and-gage set as a pair.

U. Stressing Records: Filled out during stressing operation with the following information recorded:

1. Name of Project.
2. Date of approved installation drawings used for installation and stressing.
3. Floor number and concrete placement area.
4. Date of stressing operation.
5. Weather conditions including temperature and rainfall.
6. Name and signature of inspector.
7. Name of individual in charge of stressing operation.
8. Serial or identification numbers of jack and gage.
9. Date of jack-and-gage calibration certificates.

10. Gage pressure to achieve required stressing force per supplied calibration chart.
11. Tendon identification mark.
12. Calculated tendon elongation.
13. Actual tendon elongation.
14. Actual gage pressure.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer whose full-time Project superintendent has verifiable experience and knowledge acceptable to the Engineer.

1. Superintendent must have received training from post-tensioning supplier in the operation of stressing equipment to be used on Project.

B. Source Limitations: Obtain post-tensioning materials and equipment from the same supplier.

1. Stressing jacks not provided by post-tensioning supplier must be calibrated and approved for use on Project by post-tensioning supplier.

C. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to installation and stressing of post-tensioning tendons including, but not limited to, the following:

1. Construction schedule and availability of materials, personnel, and equipment needed to make progress and avoid delays.
2. Storage of post-tensioning materials on-site.
3. Structural load limitations.
4. Coordination of post-tensioning installation drawings and nonprestressed reinforcing steel placing drawings.
5. Horizontal and vertical tolerances on tendon and nonprestressed reinforcement placement.
6. Marking and measuring of elongations.
7. Submittal of stressing records and requirements for tendon finishing.
8. Removal of formwork.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle post-tensioning materials with careful protection from corrosion.

B. High tensile steel wire or high tensile steel strand shall be supplied in coils of a sufficiently large diameter so that it will retain its physical properties and will be reasonably straight as it unwinds from the coil.

C. All wires shall be cut from certified coils. The contractor shall keep records so as to enable identification of the wires with the coil from which they were cut. At least two tensile strength samples shall be tested against each coil number.

D. Inspect tendons and accessory items at time of their delivery to Project site, prior to off-loading. Notify post-tensioning supplier of observed damage prior to off-loading.

E. Keep accurate and current records of materials delivered and used.

F. Immediately remove from Project site any tendons with damaged strand.

1.8 COORDINATION

A. Attachments and Penetrations:

1. Attach permanent fixtures such as curtain-wall systems, handrails, fire-protection equipment, lights, and security devices to the slab using embedded anchors. Drilled anchors are not allowed unless authorized in writing by the Engineer.
2. Power-driven fasteners are not allowed unless authorized in writing by the Engineer.
3. Core drilling for sleeves or other penetrations is not allowed unless authorized in writing by the Engineer.
4. Protect penetrations within (450 mm) of an anchorage with ASTM A 53/A 53M, Schedule 40 steel pipe.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Weight : 2400 Kg/m³

B. Cylinder strength at 28 days : 30 MPa

C. Minimum cement content: 400 Kg/m³

D. Creep coefficient : 2

E. Fiber reinforcement of approved properties are to be added to concrete of post-tensioned slab to enhance specially the shrinkage and temperature properties of this concrete. Other means of this enhancement may be proposed by the Contractor for the approval of the Engineer.

F. Maximum size of aggregate shall be 20mm generally and 10mm for precast units, reinforced blockwork and steel work casting.

G. The free water/cement ratio must not exceed 38%.

2.2 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A416, low relaxation, seven wire strand,

B. Strands of 12.7 mm diameter

1. Strand diameter : 12.7mm nominal
2. Strand area : 99mm²
3. Modulus of elasticity : 200000MPa
4. Minimum breaking strength of strands (MBS) : 186KN

5. Maximum number of strands per tendon = 5 strands per anchorage.

C. Strands of 15.2 mm diameter

1. Strand diameter : 15.2 mm nominal
2. Strand area : 150 mm²
3. Modulus of elasticity : 200000MPa
4. Minimum breaking strength of strands (MBS) : 279KN
5. Maximum number of strands per tendon = 5 strands per anchorage.

D. Tendon Sheathing: comply with ACI 423.6.

1. Sheathing material for bonded tendons shall be spirally wound galvanized steel tubing unless otherwise specified and shall be strong enough to retain shape and to resist unrepairable damage during construction.
2. Such sheathing material shall prevent the entrance of cement paste from the concrete, and no materials used in contact, or in conjunction, with the sheathing shall cause harmful electrolytic action nor deteriorate. At the exception of flat ducts , the inside cross sectional area of the round sheathing shall be at least two times the net area of the prestressing steel. Sheathing shall be capable of transmitting forces from grout to the surrounding concrete, and shall have grout openings at each end and at all high points, except where tendon curvature is small and the tendon is relatively level, such as in continuous slabs.

E. Anchorage Device and Coupler Assembly: Assembly of strand, wedges, and anchorage device or coupler complying with static and fatigue testing requirements in ACI 423.6 and capable of developing 95 percent of actual breaking strength of strand.

1. Anchorage Bearing Stresses: Comply with ACI 423.6 for stresses at transfer load and service load.
2. Fixed-End Anchorage Device Assemblies: Plant fabricated with wedges seated at a load of not less than 80 percent and not more than 85 percent of breaking strength of strand.

2.3 NONPRESTRESSED STEEL BARS

A. Support Bars, Reinforcing Bars, Hairpins: ASTM A 615/A 615M, Grade 420, deformed. Minimum support bar size is 13mm.

B. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening tendons and tendon support bars in place. Manufacture bar supports, according to CRSI's "Manual of Standard Practice," from steel wire, plastic, or precast concrete of greater compressive strength than concrete.

2.4 ACCESSORIES

A. Pocket Formers: Capable of completely sealing wedge cavity; sized to provide the required cover over the anchorage and allow access for cutting strand tail.

B. Anchorage Fasteners: Galvanized steel nails, wires, and screws used to attach anchorage devices to formwork.

2.5 PATCHING MATERIAL

A. Patching Material: One component, polymer-modified, premixed patching material containing selected silica aggregates and portland cement, suitable for vertical and overhead application. Do not use material containing chlorides or other chemicals known to be deleterious to prestressing steel or material that is reactive with prestressing steel, anchorage device material, or concrete. To be approved by the Engineer.

B. GROUT:

1. The grout for bonded post-tensioned concrete members shall be a neat cement grout made with ordinary Portland cement, water and an expansive admixture approved by the Engineer.
2. The grout shall be sufficiently fluid and of a uniformly colloidal consistency to enable the cable ducts to be grouted using maximum pressure of 0.5 N/mm2. The grout shall have a maximum water/cement ratio of 0.49, except where otherwise agreed in writing by the Engineer.
3. The grout admixtures shall on no account contain nitrates or other harmful chemical composition. The total chloride content in the Concrete mix expressed as a percent of chloride ion by weight of cement shall not exceed 0.06%.
4. Other additives which reduce shrinkage and/or increase workability may be used subject to the written approval of the Engineer. If two or more admixtures are to be used simultaneously in the same grout mix, the Contractor shall provide data to assess their interaction and to ensure their compatibility.
5. All ducts shall be clean and free of deleterious materials that would impair the bonding of the grout or interfere with grouting procedures. Each duct shall be thoroughly flushed and blown out with lime water and oil-free compressed air, immediately prior to grouting.
6. Additional grout pipes shall be provided through columns, where required to ensure the full grouting of the ducts.

PART 3 - EXECUTION

3.1 FORMWORK

A. Provide formwork for post-tensioned elements as specified in Division 3 Section "Cast-in-Place Concrete." Design formwork to support load redistribution that may occur during stressing operation. Ensure that formwork does not restrain elastic shortening, camber, or deflection resulting from application of prestressing force.

B. Do not remove forms supporting post-tensioned elements until tendons have been fully stressed and elongations have been approved by the Engineer, unless authorized in writing by The Engineer.

C. Do not place concrete in supported floors until tendons on supporting floors have been stressed and elongations have been approved by the Engineer, unless authorized in writing by the Engineer.

3.2 NONPRESTRESSED STEEL REINFORCEMENT PLACEMENT

A. Placement of nonprestressed steel reinforcement is specified in Division 3 Section "Cast-in-Place Concrete." Coordinate placement of nonprestressed steel reinforcement with installation of post-tensioning tendons.

B. Welding of reinforcement shall not be permitted without approval of Engineer.

C. Support all slab reinforcement at the correct levels on approved bar chairs spaced at maximum 900mm centerline to centerline both ways.

D. Provide the following cover to all reinforcement unless otherwise noted on Drawings:

1. For slabs, flat beams not exposed to earth or weather: 3.0cm
2. For drop beams: 4.0cm
3. For all surfaces in contact with water or vapour: 7.5cm

3.3 TENDON INSTALLATION

A. Install tendons according to approved installation drawings and procedures.

B. Tendon Supports: Provide continuous slab bolsters or bars supported on individual high chairs spaced at a maximum of (900 mm) o.c. to ensure tendons remain in their designated positions during construction operations and concrete placement.

1. Support tendons as required to provide profiles shown on installation drawings. Position supports at high and low points and at intervals not exceeding 1200 mm. Ensure that tendon profiles between high and low points are smooth parabolic curves.
2. Attach tendons to supporting chairs and reinforcement without damaging tendon sheathing.
3. Support slab tendons independent of beam reinforcement.

C. Minimum concrete cover to all ducts to be 50mm for slabs and beams unless otherwise noted.

D. Distance of ducts center to center of strand z=30mm.

E. Tendon Extensions:

4. The allowable extension will be +/-7% between the theoretical and actual elongation.

F. Maintain tendon profile within maximum allowable deviations from design profile as follows:

5. Maximum vertical tolerance of duct positioning to be +/-2mm.

G. Maintain minimum radius of curvature of 480-strand diameters for lateral deviations to avoid openings, ducts, and embedded items. Maintain a minimum of 50 mm of separation between tendons at locations of curvature.

H. If tendon locations conflict with nonprestressed reinforcement or embedded items, tendon placement governs unless changes are authorized in writing by the Engineer. Obtain the Engineer's approval before relocating tendons or tendon anchorages that interfere with one another.

I. Deviations in horizontal spacing and location of slab tendons are permitted when required to avoid openings and inserts.

J. Installation of Anchorage Devices:

1. Place anchorage devices at locations shown on approved installation drawings.
2. Do not switch fixed and stressing-end anchorage locations unless authorized in writing by the Engineer.
3. Attach pocket formers, intermediate anchorage devices, and stressing-end anchorage devices securely to bulkhead forms. Install stressing-end and intermediate anchorage devices perpendicular to tendon axis.
4. Install tendons straight, without vertical or horizontal curvature, for a minimum of (300 mm) behind stressing-end.
5. Embed intermediate anchorage devices at construction joints in first concrete placed at joint.
6. Minimum splice length in reinforcing bars at anchorages is 600mm. Stagger splices a minimum of 1500mm.
7. Place fixed-end anchorage devices in formwork at locations shown on installation drawings. Support anchorages firmly to avoid movement during concrete placement.

K. Maintain minimum concrete cover as follows:

1. Top and bottom cover : min 50mm PT cables CGS.
2. Interior spans: min 50mm PT cables CGS (40mm chair height).
3. Exterior spans: min 50mm PT cables CGS (40mm chair height).

L. Maintain minimum clearance of 150 mm between tendons and openings.

M. Prior to concrete placement, mark tendon locations on formwork with spray paint.

N. Paint markings on formwork will be transferred to concrete, allowing tendon locations to be determined by examination of slab soffit. Use alternate method of marking tendon locations if soffit is to be exposed or such markings are not desired.

O. Do not install sleeves within 900 mm of anchorages after tendon layout has been inspected unless authorized in writing by the Engineer.

P. Do not install conduit, pipe, or embeds requiring movement of tendons after tendon layout has been inspected unless authorized in writing by the Engineer.

Q. Do not use couplers unless location has been approved by the Engineer.

R. Damage to the tendons shall be prevented at all stages of construction. Minimum protective requirements include:

1. Provision of planks on blocks across slab bands for access.
2. Adequate restraint of concrete pump lines and placing on stools or timber blocks above ducts.

3.4 SHEATHING INSPECTION AND REPAIR

A. Inspect sheathing for damage after installing tendons. Repair damaged areas by replacing tendon sheathing.

1. Ensure that sheathing is watertight and there are no air voids.
2. Sheaths shall be kept free of any matter detrimental to the bond between the sheath and grout and, except for material sealing a sheath joint, between the sheath and the concrete.
3. The ends of all ducts and tendons shall be respectively sealed and protected until the tendon is threaded through and the stressing operations are commenced.
4. The number and position of grout vents for entry and outlet points, and for checking that the entire length of duct has been adequately grouted, shall be agreed with the Engineer before the ducts are formed.

B. Immediately remove and replace tendons that have damaged strand.

3.5 CONCRETE PLACEMENT

A. Do not place concrete until placement of tendons and nonprestressed steel reinforcement has been inspected.

B. Provide the Engineer minimum of 48 hours' notice before concrete placement.

C. Place concrete as specified in Division 3 Section "Cast-in-Place Concrete." Ensure compaction of concrete around anchorages.

D. Ensure that position of tendon and nonprestressed steel reinforcement does not change during concrete placement. Reposition tendons and nonprestressed steel reinforcement moved during concrete placement.

E. Ensure that method of concrete placement does not damage tendon sheathing. Do not support pump lines, chutes, or other concrete placing equipment on tendons.

3.6 TENDON STRESSING

A. Calibrate stressing jacks and gages at start of job and at least every six months thereafter. Keep copies of calibration certificates for each jack-and-gage pair on Project site and available for inspection. Exercise care in handling stressing equipment to ensure that proper calibration is maintained.

B. Stress tendons only under supervision of qualified post-tensioning superintendent.

C. Stressing operations shall not occur before three days after casting. The minimum concrete strength at stressing shall be 35MPa.

D. Applied jacking force behind anchor to be 140KN (75% of breaking load) for each 12.7mm strand.

E. Stressing Sequence:

1. Jack to 25% of jacking force at initial concrete strength fci = 15MPa minimum, concrete cylinder strength, (approximately 24 HRS after pour).

2. Jack to 100% of jacking force at initial concrete strength fci = 40 MPa minimum, concrete cylinder strength.
3. Stressing to be carried out in transverse direction to slab bands first where applicable.

F. Minimum of two concrete standard field cured test cylinders shall be tested to determine concrete strength before each stressing stage.

G. Perform tensioning in three steps minimum. Measure prestressing force. Maintain jacking and tensioning records as work progresses.

H. Stage stress according to schedule shown on the Contract Drawings.

I. If detensioning and restressing of tendon is required, discard wedges used in original stressing and provide new wedges.

J. Mark and measure elongations to include:
1. Identification number of dynamometers, gauges, pumps and jacks.
2. Identification particulars of tendons.
3. Identification of the structural member where the tendon is used.
4. Initial force (or pressure) whereon tendons are marked for measurement of elongation.
5. Final force (or pressure) and elongations obtained on completion of tensioning.
6. Elongations remaining after release of jacks.
7. Ram pressures.
8. Elongation obtained at suitable intervals during tensioning together with corresponding force (or pressure) if and when required by the Engineer.

K. Submit stressing records within one day of completion of stressing. If discrepancies between measured and calculated elongations exceed plus or minus 7 percent, resolve these discrepancies to satisfaction of the Engineer.

L. Prestressing will be considered acceptable if gage pressures shown on stressing record correspond to required stressing force and calculated and measured elongations agree within 7 percent.

M. If measured elongations deviate from calculated elongations by more than 7 percent, additional testing, restressing, strengthening, or replacement of affected elements may be required.

N. Grouting:
1. Ducts shall be grouted as soon as practicable after the tendons in them have been stressed and the Engineer's permission to commence has been obtained. Grout shall be injected in one continuous operation, and allowed to flow from the vents until the consistency is equivalent to that being injected.
2. The ducts shall be completely filled with grout.
3. Vents shall be sealed consecutively in the direction of flow.

3.7 TENDON FINISHING

A. After grouting, the temporary sealing mortar is to be removed where applicable, from sides and bottom faces of recesses and filled with well vibrated stiff concrete mix, f'c=45MPa and Slump=40mm.

B. Do not cut strand tails or cover anchorages until stressing records have been reviewed and approved by the Engineer.

C. Cut strand tails as soon as possible after approval of elongations.

D. Patch stressing pockets within one day of cutting strand tail. Clean inside surface of pocket to remove laitance or post-tensioning coating before installing patch material. Finish patch material flush with adjacent concrete.

3.8 PROTECTION

A. Do not expose tendons to electric ground currents, welding sparks, or temperatures that would degrade component.

B. Protect exposed components within one workday of their exposure during installation.

C. Prevent water from entering tendons during installation and stressing.

D. Provide weather protection to stressing-end anchorages if strand tails are not cut within 10 days of stressing the tendons.

3.9 REPAIRS

A. Submit repair procedure to the Engineer for evaluation and approval.

B. Do not proceed with repairs requiring removal of concrete unless authorized in writing by the Engineer.

SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes but not limited to the following:

1. Precast Concrete Curbs.
2. Precast concrete wheel stopper.
3. Others as shown on drawings

B. Related sections include the following:

1. Division 3, Section 033000 “Cast In Place Concrete”.
2. Division 5 Section “Metal Fabrications”.

1.3 DEFINITION

A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by the Engineer.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests by a qualified independent testing agency.

D. Shop Drawings: Detail fabrication and installation of architectural precast concrete units. Indicate locations, plans, elevations, dimensions, shapes and cross sections of each unit. Indicate joints, reveals, and extent and location of each surface finish.

1. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware and connections.
2. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
3. Indicate relationship of architectural precast concrete units to adjacent materials.
4. Indicate locations and details of anchors and joint widths.

E. Samples: For each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of 3, illustrating full range of finish, color and texture variations expected. The Engineer's approval of the samples will not be considered final and the Engineer may reject any precast units delivered to the Site, which do not, in his opinion, meet the required standards.

F. Qualification Data: For Installer, fabricator, and engineer.

G. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications and standards, except as otherwise indicated:

1. ACI 318 "Building code requirements for structural concrete".
2. Precast/prestressed concrete institute MNL 122 "Architectural Precast Concrete".
3. Prestressed Concrete Institute MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products".
4. American Welding Society D1.4, "Structural Welding Code - Reinforcing Steel".

B. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

C. Fabricator Qualifications: Shall comply with the following requirements:

1. Has sufficient production capacity to produce required units without delaying the work.
2. Is experienced in manufacturing precast concrete curbs units and tiles similar to those indicated for this project and can demonstrate a record of successful in-service performance

D. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated and approved by the Engineer.

E. Mockups: After sample approval and before fabricating architectural precast concrete units, product items requested by the Engineer for review by the Engineer. Incorporate full-scale details of architectural features, finishes, textures, and transitions in samples.

1. Locate mockup(s) where indicated or, if not indicated, as directed by the Engineer.
2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
3. After acceptance of repair technique, maintain one sample panel at manufacturer's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove sample panels when directed.
5. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents unless such deviations are specifically approved by the Engineer in writing.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver precast units to Project Site in such quantities and at such times to ensure continuity of installation.

B. Support units during shipment on nonstaining shock-absorbing material.

C. Place stored units so identification marks are clearly visible, and units can be inspected.

D. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

E. Store units at project site to prevent cracking, staining, or other physical damage to protective finish coatings.

PART 2 - PRODUCTS

2.1 FORMWORK

A. Provide forms and, where required, form facing materials of metal, plastic, wood, or other acceptable material that is non-reactive with concrete and will produce required finish surfaces within fabrication tolerances indicated.

1. All forms shall be sufficiently strong and rigid and securely staked and braced to obtain a finished product correct to the dimensions, lines and grade required. Forms shall be cleaned and oiled before each use.

2. Mold-release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed when welding is required.

C. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I.

B. All precast Units should be of “Fairface” type, to the approval of the engineer.

1. Use white portland cement for facing concrete mix to match control sample.

2. Standard gray portland cement may be used for non-exposed back-up concrete.

C. Coarse Aggregate for Facing Mixes: ASTM C 33 for "Severe Weathering Region"; hard, durable, carefully selected and graded; free of material causing staining or reacting with

cement and with less than 5% magnesium sulfate soundness loss unless at least 5 years historical experience indicates satisfactory durability.

D. Fine Aggregate for Facing Mixes: ASTM C 33; manufactured sand of same material as coarse aggregate, unless otherwise acceptable to The Engineer.

E. Water: Drinkable, free from foreign materials in amounts harmful to concrete and embedded steel.

F. Air-Entraining Admixture: ASTM C 260.

G. Water-Reducing Retarding, Accelerating Admixtures: ASTM C 494, Type as selected by Fabricator and containing not more than 0.1% chloride ions. Certified by manufacturer to be compatible with other required admixtures.

2.4 STEEL CONNECTION MATERIALS

A. Steel Plates: Structural quality, hot-rolled carbon steel, ASTM A 283, Grade C.

B. Steel Shapes: ASTM A 36.

C. Anchor Bolts: Expansion steel bolt, ASTM A 307, low-carbon steel bolts, regular hexagon nuts and carbon steel washers.

D. Electrodes for Welding: Comply with AWS Code.

2.5 ACCESSORIES

A. Reglets: Stainless steel, Type 302 or 304, felt or fiber filled, or with face opening of slots covered.

B. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install architectural precast concrete units

2.6 CONCRETE CURBS

A. Each precast curb or gutter unit shall normally be 500 mm in length and this length shall be reduced to 200 mm or as directed, where units are to be installed along curves of less than 10 m radius.

B. For horizontal curves of radius less than 10 m, curb and gutter units shall be manufactured to the radius shown and in such circumstances straight elements or portions of straight elements shall not be used. Bull noses and curved faces shall be of constant radius with a smooth change from radius to plain face.

C. Portland Cement: ASTM C 150, Type I.

D. Finish: fairfaced.

E. Dimensions: as shown on Drawings.

F. F’c: 30Mpa unless otherwise noted.

2.7 Wheel stop and curbs.

A. Portland Cement: ASTM C 150, Type I.

B. Finish: fairfaced.

C. Dimensions: as shown on Drawings.

D. F'c: 25Mpa unless otherwise noted.

2.8 MIX DESIGN

A. Prepare design mixes for each type of concrete required.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.

C. Mix: Standard-weight concrete consisting of specified Portland cement, aggregates, admixtures, and water to produce the following properties:

1. Compressive Strength: 25 MPa minimum at 28 days.
2. Total Air Content: Not less than 4% nor more than 6%.
3. Water Absorption: Not to exceed 5% to 6% by weight; except between 3% to 4% for sloping surfaces (sills), for improved weathering staining resistance.
4. Max W/C ratio 0.45.
5. Cement content: minimum 300Kg/m3

D. Blinding and Backing Concrete: Standard-weight concrete with compressive strength of 15 MPa at 28 days and cement content of 250Kg/m³ with a maximum aggregate size equal to 60 mm unless otherwise noted.

E. Precast concrete base: Standard-weight concrete with compressive strength of 20 MPa at 28 days.

F. Mortar: Sand /cement with plasticizer mortar (3:1) shall be composed of one part of cement to three parts of sand by volume with a mixture of an approved plasticizing agent, if required, added in accordance with the manufacturer's instructions. Mortar shall be mixed by approved mechanical mixers. Sand shall be natural sand or crushed natural stone or a combination of both as specified in BS 1200.

G. Admixtures: Use air-entraining admixture in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete, may be used at Fabricator's option.

2.9 FABRICATION

A. General: Fabricate architectural precast concrete units complying with manufacturing and testing procedures, quality control recommendations, and following dimensional tolerances unless otherwise indicated.

B. Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

C. Comply with the following tolerances or PCI MNL 117 whichever is most stringent and applicable.

1. Local Smoothness: 6 mm per 3 m.
2. Warping: 1.5 mm per 300 mm of distance from nearest adjacent corner.
3. Thickness: Plus or minus 3 mm.
4. Tolerances of other dimensions not otherwise indicated. Plus or minus 1.5 mm.
5. Tipping and Flushness of Plates: Plus or minus 6 mm.
6. Dimensions of Architectural Features: Plus or minus 3 mm.Precast units shall be cast upside down in approved steel molds under conditions of controlled temperature and humidity. The units shall be steam cured, or cured by another method approved by the Engineer, until the concrete attains the full specified 28-day strength.

D. Fabricate units straight, smooth, and true to size and shape, with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

1. Architectural precast concrete units which are cracked, broken, spalled, stained, or otherwise defective will not be acceptable.

E. Built-In Items: Provide reglets, slots, holes, and other accessories in units as indicated and required.

1. Provide inserts and anchorages cast into units, for attachment of loose hardware as required.

F. Anchorages: Provide loose steel plates, clip angles, anchors, dowels, cramps, and other miscellaneous steel shapes not provided by other trades, necessary for securing architectural precast concrete units to supporting and adjacent members.

2.10 FINISHES

A. Surfaces of precast units that will be exposed to view after installation shall be fairface, true and even, with a dense finish of uniform texture and color, free from cracks, holes, fins, staining or other blemishes or defects. Units failing to meet these requirements will be rejected.

B. Surface Finish: Fabricate precast units and provide exposed surface finishes as follows:

1. Color and Texture: Fairface surface finish free of pockets, sand streaks, and honeycomb, with uniform color and texture match the following approved by the Engineer. Provide the following as indicated or directed by the Engineer.
   a. Design Reference Sample(s).
   b. Mockup(s).

C. Paint shall be supplied by an approved manufacturer. It shall be suitable for applying by brush, roller or by airless spray to give a chemically stable film of uniform thickness and shall be chlorinated rubber, one pack epoxy or alkyd based.

D. The paint shall be supplied fresh and ready for use in sealed containers and shall be stored and applied in accordance with the manufacturer's instructions.

2.11 REFORMED EXPANSION JOINT FILLER

A. Preformed expansion joint filler shall conform to AASHTO M 33.

2.12 EPOXY ADHESIVE (WHERE REQUIRED)

A. Epoxy adhesive (for use in attaching precast units to existing concrete surfaces) shall be a 2 components epoxy of high viscosity and rapid setting characteristics, conforming to AASHTO M237, Class II

2.13 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144, or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for dry pack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.

2.14 SOURCE QUALITY CONTROL

A. Quality-Control Testing; Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants".

B. Engage an independent testing agency to evaluate architectural precast concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Provide the testing agency with samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Require Installer to examine surfaces to receive architectural precast concrete and conditions under which architectural precast concrete will be installed and to report in writing any conditions which are not in compliance with requirements. Do not proceed with installation until surfaces and conditions comply with requirements indicated in specifications or elsewhere for execution of other work which affects architectural precast concrete.

3.2 PREPARATION

A. Advise Installers of other work about specific requirements relating to placement of inserts, flashing reglets and similar items which will be used by Architectural Precast Concrete Installer for anchoring, supporting and flashing of stonework. Furnish Installers of other work with drawings or templates showing locations of these items.

B. Clean architectural precast concrete surfaces which have become dirty or stained prior to setting to remove soil, stains and foreign materials. Clean units by thoroughly scrubbing with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh filler or abrasives.

3.3 INSTALLATION

A. General: Deliver anchorage items which are to be attached or embedded in other construction before start of such work. Provide setting diagrams, templates, instructions and directions as required for installation.

B. Install clips, hangers, bearing pads, dowels and other accessories required for connecting architectural precast concrete units to supporting members and backup materials

C. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.

1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting elements.

D. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

E. Do not permit connections to disrupt continuity of flashing.

F. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

G. If approved, forms for the concrete base may be omitted and the concrete placed directly against undisturbed excavated faces.

H. Base course concrete shall be placed, compacted and shaped to the sections shown on the Drawings. Concrete shall be compacted with an approved internal type vibrator or if approved, by hand spudding and tamping. Edges shall be rounded if necessary by the use of wood molding or by the use of an edger as applicable. The concrete base shall be finished to a true and even surface with a wood float. Concrete shall be membrane or water cured for at least 7 days before precast units are placed thereon.

I. Elements shall be set to the lines and grades as shown on the Drawings.

J. Precast units shall be soaked in water immediately before installation.

K. Units shall be set accurately in position in 25mm thick mortar bed on the precast concrete base.

L. Joints between precast units shall not be mortared unless otherwise shown on the Drawings. Units shall be closely spaced and every 10 m run shall be provided with an expansion joint 10mm thick.

M. Where specified, joint filler, sealant and backing rod used at joints shall be approved by the Engineer. The filler shall extend through the curb, bed, backing and channel, and shall be trimmed to the finished shape of the curb and channel.

N. After curbs have been installed, steel forms shall be erected, if required, and concrete backing shall be placed as shown on the Drawings. Pavement courses shall not be laid against curbs until the concrete backing has membrane or water cured for at least 14 days. The concrete backing shall be protected from drying out and against the harmful effects of weather, including rain and rapid temperature changes. The method of protection shall be subjected to the Engineer approval. The use of colored curing membranes will not be permitted.

O. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.

P. Accessories: Install clips, and other accessories required for erection of precast units to supporting members and back-up materials.

Q. Cleaning: Clean exposed facings to remove dirt and stains which may be on units after erection and completion of joint treatments. Wash and rinse in accordance with manufacturer's recommendations. Protect other work from damage due to cleaning operations.

3.4 ERECTION TOLERANCES

A. Erect architectural precast concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the special inspections and prepare reports.

B. Remove and replace work that does not comply with specified requirements.

C. Additional testing and inspecting, at the Contractor’s expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 REPAIRS

A. Repair architectural concrete units if permitted by the Engineer to match color, texture, and uniformity of surrounding precast concrete units. The Engineer reserves the right to reject repaired units that do not comply with requirements.

3.7 CLEANING

A. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.

2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

SECTION 035300 – CONCRETE TOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes

1. Cement-based, screed.
2. Fully bonded polymer modified leveling screed.

B. Related Sections include the following:

1. Division 3 Section “Cast-In-Place Concrete”.

1.3 DEFINITION:

A. Concrete floor topping means a layer of cement-sand or other material, with or without reinforcement, laid on the floor or roof slab to achieve correct level or to receive another material.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Samples: Submit samples of each of the above product, cement, aggregate and sand.

D. Mix Design and Test Reports: For each mix used for concrete floor topping.

E. Joint details and arrangements.

F. Test reports for field control testing.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer (applicator) who is acceptable to manufacturer, who has completed concrete floor topping applications similar in material and extent to that required for this Project, and whose work has resulted in construction with a record of successful in-service performance.

B. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written recommendations for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting screed performance.

1. Place concrete floor topping only when ambient temperature and temperature of base slabs are between 10 and 30ºC.

B. Close areas to traffic during topping application and for time period after application recommended in writing by manufacturer.

1.8 COORDINATION

C. Coordinate concrete floor topping with requirements of finish flooring products.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. Concrete floor topping: cement-sand mix with admixtures applied over structural deck or geotextile protection layer.

1. Portland Cement: ASTM C 150, Type I.
2. Compressive Strength: Not less than 20 MPa at 28 days when tested according to ASTM C 109/C 109M.
3. Water-cement ratio: Adjust ratio to achieve the required compressive strength and slump.
4. Minimum cement content: 250 Kg/m³.
5. Topping Additive: plasticisers and water-retaining agents formulated for use with screed when applied to substrate and conditions indicated and to approval of the Engineer.

B. Deformed – Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet of sizes and diameters as required by the engineer,

C. Fiberglass reinforcement mesh where required by the engineer.

D. Fibrous Reinforcement: 100 % virgin polypropylene, fibrillated fibers containing no re-processed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Proportion shall be 0.9 Kg per m3 of concrete. Fibrous reinforcement shall be as follows:

1. Specific gravity: 0.91
2. Tensile strength: 345 - 758 N/mm2

E. Concrete floor topping over 60mm thick shall be reinforced.

F. Aggregate Topping: Normal Weight Aggregate: ASTM C 33 and as follows:

1. Fine aggregate, consisting of sand or crushed stone screenings, clean, hard, free of deleterious matter. Grade by weight to pass sieves as follows:
   a. 9.5 mm: 100 percent
   b. 4.8 mm: 95-100 percent
   c. 2.4 mm: 80-90 percent
   d. 1.2 mm: 50-75 percent
   e. 600 micrometers: 30-50 percent
   f. 300 micrometers: 10-20 percent
   g. 150 micrometers: 2-5 percent
2. Coarse aggregate, consisting of gravel or crushed stone, clean, hard, free of deleterious matter. Grade by weight to pass sieves as follows:
   a. 12.5 mm: 100 percent
   b. 9.5 mm: 30-50 percent
   c. No. 4: 0-15 percent
   d. No. 8: 0-5 percent

2.2 POLYMER MODIFIED CEMENT FLOOR SCREED MATERIALS

A. Manufacturers: Flowcrete UK, Mapei, Sodamco-Weber, Lafarge or approved equal.

B. Slurry Bond Coat: Factory prepared blend of selected polymers, Portland cement, and graded aggregate blended with specially designed latex admixture.

1. Water Absorption: 4% max (ANSI A118.6-4.4)
2. Compressive Strength: 34.5 MPa min (ANSI 118.4-6.1)
3. TCA Service Rating: Extra Heavy (ASTM C-627)
4. Tensile Bond: 1575N min (BS 5980:1980 Class AS; 14 days)
5. Shear Adhesion: 22.8N min(BS 5980:1980 Class AS; 14 days)

C. Thick Bed Mortar and Mortar Admix: Factory prepared blend of selected polymers, Portland cement, and graded aggregate blended with specially designed latex admixture to produce an early drying, high strength screed and resistance to construction traffic.

6. Water Absorption: 5% max (ANSI A118.6-4.4)

7. Compressive Strength: 33.8MPa min (ANSI 118.4-6.1)

8. TCA Service Rating: Extra Heavy (ASTM C-627)

9. Tensile Bond: 1575N min (BS 5980:1980 Class AS; 14 days)

10. Shear Adhesion: 22.8N min(BS 5980:1980 Class AS; 14 days)

D. Steel reinforcement: 50 x 50mm x 1.6mm diameter galvanized steel welded wire mesh complying with ANSI A108.02 3.7, ASTM A185 and ASTM A82.

2.3 SURFACE HARDENING AND COLOR MATERIALS

A. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

1. Color: As selected by Engineer from manufacturer's full range.

B. Colored-Powder Release Agent: Factory-packaged dry combination of surface conditioning and dispersing agents interground with coloring pigments that facilitates release of stamp mats. Use coloring pigments that are finely ground, nonfading mineral oxides interground with cement.

2. Color: As selected by Engineer from manufacturer's full range.

C. Surface Hardening Compound/ Colored Dry-Shake Hardener: monolithic surface hardening compound that provides an extremely hard wearing, abrasion and impact resistant surface.

3. Shall be factory blended powder which is ready to use onsite.

4. Shall consist of selected and graded aggregate, Portland cement and special additives to improve workability, providing a material which is easy to trowel into the surface of fresh wet concrete

5. Hardening compound with metallic aggregate shall not be used.

6. Use coloring pigments that are finely ground, nonfading mineral oxides interground with cement

7. Properties:

a. Abrasion resistance: improves the abrasion resistance of concrete floors by over 300%, ASTM C779 - 89a

b. 28 day compressive strength: 70 N/mm², to BS 1881 part 116 1983.

c. Hardness (Mohs scale): 9

8. Color: as selected by the Engineer.

9. Application: as per Manufacturer instructions.

10. Product: Nitoflor Emeritop, Fosroc or approved equal.

D. Concrete hardening and dustproofing liquid/finish: low viscosity liquid for application to concrete/Screed.

11. Shall be an aqueous solution of sodium silicate plus surface active chemicals.

12. Application: as per Manufacturer instructions.

13. Product: MASTERTOP 20, BASF or approved equal.

2.4 SEALING MATERIALS

A. Clear Acrylic Sealer: Manufacturer's standard waterborne, membrane-forming, medium-gloss, acrylic copolymer emulsion solution containing not less than 15 percent solids by volume; nonyellowing and UV resistant.

2.5 CURING MATERIALS

A. Evaporation Retarder: Water borne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 305 g/sq. m when dry.

C. Water: Potable.

2.6 DESIGN MIXES

A. Prepare design mixes for each type and strength of concrete screed by either laboratory trial batch or field-test data methods. For trial batch method, use a qualified independent testing agency for preparing and reporting proposed mix designs.

B. Limit water-soluble chloride ions to the maximum percentage by weight of cement or cementitious material permitted by ACI 301.

2.7 RELATED MATERIALS

A. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.

B. Joint-Filler Strips: ASTM C 578, expanded polystyrene.

C. Water: Potable.

D. Admixtures: Admixtures certified by manufacturer to contain not more than 0.1 % water-soluble chloride ions by mass of cementitious material and compatible with other admixture and cementitious materials. Do not use admixtures containing calcium chloride.

E. Acrylic-Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

F. Epoxy Adhesive: ASTM C 881, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

A. Fill under screed:

1. Sound, naturally occurring material, or angular crushed stone, clean and free from orgaic matter and unsuitable material or other deleterious substances and be in such condition that it can be readily compacted under watering and rolling to form a firm and stable base. Sieve analysis and gradation of granular base material shall be submitted to the Engineer for approval.

2.8 MIXING

A. Bonding Slurry: Mix 1 part portland cement and 2 parts sand with water and an acrylic-bonding agent according to manufacturer's written instructions to a thick paint consistency.

B. Screed Mix: Design mix, with or without admixture, to produce concrete floor topping material with the following characteristics:

1. Compressive strength: at 28 days not less than 20 Mpa.
2. Slump: maximum 125 mm
3. Mix proportions: submit mix for approval to give a 28 day compressive strength of not less than 20 MPa. Minimum cement sand ratio should be not less than 1:4 by volume.
4. Maximum w/cm ratio: 0.51.

C. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of screed. Proceed with application only after unsatisfactory conditions have been corrected.

B. Verify that base slabs meet finish and surface profile requirements in Division 3 Section "Cast-in-Place Concrete."

3.2 PREPARATION

A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of 6 mm.

1. Prepare and clean existing base slabs according to topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
2. Mechanically remove contaminants from existing concrete that might impair bond of topping.
3. Saw cut contraction and construction joints in existing concrete to depth as shown on drawings and fill with semirigid joint filler.

B. Install joint-filler strips at concrete topping construction joint and where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips below topping surface as shown on drawings where joint sealants are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.3 FLOOR TOPPING APPLICATION

A. Start floor topping application in presence of manufacturer's technical representative.

B. Fibrous Reinforcement: For reinforced screeds, apply fibrous reinforcing as per manufacturer’s written instructions.

C. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

1. Screed surface with a straightedge and strike off to correct elevations.
2. Slope surfaces uniformly where indicated.
3. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

D. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel so no blisters develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.

    a. Finish and measure surface so gap at any point between screed surface and an unleveled freestanding 3-m- long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed 6.4 mm.

E. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by the Engineer.

1. Construction joints locations and limits as shown on drawings and as required by the engineer.

2. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.

F. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 3-mm- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete floor topping develops random contraction cracks.

1. Form joints in concrete floor topping over contraction joints in base slabs, unless otherwise indicated.

2. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than 13 mm deep.

3.4 PROTECTION AND CURING

A. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.

B. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry or windy conditions before and during finishing operations. Apply according to manufacturer’s written instructions after placing screeding, but before float finishing.

C. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with water or absorptive cover, water saturated and kept continuously wet. Cover concrete floor topping surfaces and edges with 300-mm lap over adjacent absorptive covers.

3.5 JOINT FILLING

A. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

3.6 REPAIRS

A. Defective Topping: Repair and patch defective concrete floor topping areas.

B. After finishing the screed layer (next day), Apply cement grout repair layer by mean of Special Machinery “Helicopter”, to fill all cracks and voids, as directed by the engineer.

3.7 FIELD QUALITY CONTROL

A. Sample Sets: At point of placement, testing and inspecting agency shall take a set of 3 molded-cube samples from the topping mix for the first 90 m2 plus 1 set of samples for each subsequent 464 m² of topping, or fraction thereof, but not less than 6 samples for each day's placement. Samples shall be tested according to ASTM C 109/C 109M for compliance with compressive strength requirements.

B. Concrete floor topping shall be tested for delamination by dragging a steel chain over the surface.

C. Concrete floor topping shall be tested for compliance with surface flatness and levelness tolerances.

D. Remove and replace applications of concrete floor topping where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 FULLY BONDED CONSTRUCTION:

A. Before laying screed/topping completely remove mortar matrix from surface to expose coarse aggregate over entire area of hardened base using abrasive blasting or, for in situ slabs only, pneumatic scabbling. Remove all dust and debris and wash clean.

B. Keep surface well wetted for several hours before laying screed/topping. Remove free water then brush in a slurry bonding coat of creamy consistency.

1. Slurry: Polymer modified bonding agent.

C. As an alternative to wetting and slurrying, prepare, prime as necessary and apply a bonding agent to manufacturer's recommendations. Bonding agent: to approval.

D. Lay screed/topping while slurry or bonding agent is still wet to ensure a good bond

3.9 CLEANING AND PROTECTING

A. Protect concrete floor topping from damage and wear during the remainder of construction period. Use protective methods and materials approved by the Engineer, including temporary covering.

B. Clean concrete floor topping not more than 4 days before dates scheduled for inspections intended to install final finishes.

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry unit (Hollow and Solid blocks).
2. Mortar and grout.
3. Ties and anchors.
4. Masonry Joint Reinforcement.
5. Columns and beams.
6. Embedded Flashing.
7. Miscellaneous masonry accessories.

B. Related Sections include the following:

1. Division 3 Section "Cast-In-Place Concrete".
2. Division 9 Section “Portland Cement Plaster”

1.3 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops the following net-area compressive strengths (f'm) at time of delivery to the purchaser in accordance with ASTM C 129. Determine compressive strength of masonry by testing masonry prisms according to ASTM C 1314.
For Concrete Unit Masonry: minimum f'm = 10 MPa.

1.4 SUBMITTALS

A. Product Data: For each different masonry unit, accessory, and other manufactured product specified. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Shop drawings including full details of masonry works for different assemblies and covering anchorage to concrete elements, flashings, masonry reinforcement,

bond pattern, joints, joint reinforcement, openings, steel reinforcement and formwork details for columns, beams and other details as the Engineer may require.

D. Samples: For the following:

1. Full-size units for each different exposed masonry unit required, showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction.
2. Accessories embedded in the masonry.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

F. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:

1. Each type of masonry unit required.
    a. Include size-variation data for block, verifying that actual range of sizes falls within specified tolerances.
    b. Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.
2. Portland cement for concrete complying with ASTM C 150, type 1.
3. Reinforcing bars complying with ASTM A 615M, Grade 60.
4. Mortar complying with property requirements of ASTM C 270.
5. Grout mixes complying with compressive strength requirements of ASTM C 476. Include description of type and proportions of grout ingredients.

G. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:

1. Each type of masonry unit required.
    a. Include size-variation data for block, verifying that actual range of sizes falls within specified tolerances.
    b. Include test data, measurements, and calculations establishing net-area compressive strength of masonry units.
2. Each cement product required for concrete, mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
3. Each combination of masonry unit type and mortar type. Include statement of net-area compressive strength of masonry units, mortar type, and net-area compressive strength of masonry.
4. Each material and grade indicated for reinforcing bars.
5. Each type and size of anchor, tie, and metal accessory.

H. Mix Designs: for each type of concrete, mortar and grout include description of type and proportions of ingredients.

I. Include test reports, per ASTM C 780 for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content..

J. Include test reports per ASTM C 1019 for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1093 to conduct the testing indicated, as documented according to ASTM E 548.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Preconstruction Testing Service: Engage a qualified independent testing agency to perform the following preconstruction testing:

1. Prism Test: For each type of wall construction indicated, per ASTM C 1314.
2. Mortar Test: For mortar properties per ASTM C 270.
3. Grout Test: For compressive strength per ASTM C 1019.

E. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

F. Sample Panels: Before installing unit masonry, build sample panels, using materials indicated for the completed work, to verify selections made under sample submittals and to demonstrate aesthetic effects. Build sample panels for each type of exposed unit masonry assembly in sizes approximately 1200 mm long by 1200 mm high by full thickness.

1. Locate panels in the locations indicated or, if not indicated, as directed by Engineer.
2. Clean exposed faces of panels with masonry cleaner indicated.
3. Protect approved sample panels from the elements with weather-resistant membrane.
4. Maintain sample panels during construction in an undisturbed condition as a standard for judging the completed work.

G. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels, unless such deviations are specifically approved by Engineer in writing.

1. Demolish and remove sample panels when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes. If

units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Reinforcing bars shall be stored on rack clear of the ground.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 600 mm down both sides and hold cover securely in place.
2. Where one Wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 600 mm down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projection from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1 ASCE 6 / TMS 602. Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.

1. When ambient temperature exceeds 38 deg C, or 32 deg C with a wind velocity greater than 13 km/h, do not spread mortar beds more than 1200 mm ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. General: Provide shapes indicated and as follows:

1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners, unless indicated as bullnose.

B. Concrete Masonry Units: ASTM C 129 and as follows:

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of:
   a. 10 MPa. for normal weight units
2. Weight Classification: Normal weight.
3. Provide moisture-controlled units. All masonry units shall be factory cured.
4. Size: Manufacturer's standard units with nominal face dimensions for modular applications indicated x thicknesses indicated.
5. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated or required.
6. Provide fire resistance rates units where indicated or required.
7. Provide fair-faced hollow blocks where indicated, having a perfectly even, granular, clean and smooth surface finishing free from cracks or any other defects.
8. Integral Water Repellent: Provide units made with integral water repellent where indicated.

   Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.
9. Reinforce masonry unit cores and cavities with reinforcement bars and grout as indicated.
10. All Reinforced cells shall be fully grouted.
11. Masonry walls shall be restrained at the soffit of slabs and beams by means of 5 mm thick galvanized mild steel angles fixed to the concrete as shown on drawing and details.

C. Fire Rated Masonry Assemblies

1. Care shall be exercised to solidly fill all joints, vertical and horizontal, with mortar.
2. Lay masonry in full bed of mortar with full head joints, properly jointed with other work. Butter vertical joints their entire depth and length. Sloughing of mortar into joints is not permitted. Bond each course at corners and intersections.
3. Build to height shown on drawings. At fire rated partitions, fill void with approved fire stop material.
4. Joints to structure above or adjoining are to be prefabricated, fire rated joint system comprising fire rated compressible filler, backing rod and fire rated elastomeric silicone joint sealant on each face of the assembly at head of wall, labeled by UL or tested to BS 476 as rated for fire rating indicated .

5. Penetrations through fire rated masonry walls shall be sealed and treated with firestopping material systems labeled by UL or tested to BS 476.
6. Provide concrete stiffener columns in concrete masonry walls greater than 5m in length at maximum 5000mm intervals.
7. For control joints in fire resisting walls, if indicated on drawings, use fire stopping materials.
8. Maintain the rating of fire-rated partitions. Provide openings of minimal size to limit the amount of required firestopping.
9. All fire rated blockwork walls shall be reinforced vertically using 12mm diameter reinforcing bars placed in every cell.
10. All accessories used in construction of fire rated assemblies shall be certified as suitable for use in fire rated masonry assemblies of rating indicated.
11. At all openings in blockwork walls, two continuous voids of hollow blockwork for the full height of the wall immediately adjacent to the opening are to be completely filled with class C200 concrete, with maximum aggregate size 10 mm.

2.2 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: Not Allowed.

C. Compressive strength shall not be less than 5 ±1 N/ mm2.

D. Pre-Packaged Portland Cement Mix: Pre-Packaged blend of Portland cement complying with ASTM C 150, Type I.

E. Aggregate for Mortar: ASTM C 144; except for joints less than 6.5 mm thick, use aggregate graded with 100 percent passing the 1.18 mm sieve.

F. Aggregate for Grout: ASTM C 404.

G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

H. Water: Clear and potable.

I. Mix grout in accordance with ASTM C 94.

J. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C 476.

1. Minimum compressive strength of 14MPa at 28 days.

K. Add admixtures in accordance with manufacturer's instructions

2.3 REINFORCING STEEL

A. Steel Reinforcing Bars: Material and grade as follows:

B. Uncoated Steel Reinforcing Bars: ASTM A615M, Grade 75.

2.4 CONCRETE LINTELS, JAMBS, COLUMNS AND BEAMS

A. General: Provide concrete lintels, jambs, columns and beams complying with requirements in Division 3 Section “Cast-In-Place Concrete” and as shown in detail drawing.

2.5 MASONRY JOINT REINFORCEMENT

A. Materials: Galvanized metal lath having a minimum intensity of 1.61 Kg/m². Width of lath shall be 50mm less than nominal width of wall with uniform 25mm recess from wall face at edges.

2.6 TIES AND ANCHORING DEVICES

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 641/A 641M.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 16-mm cover on outside face. Outer ends of wires are bent 90 degrees and extend 50 mm parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 100 mm wide.

1. Where wythes do not align, are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 32 mm.
2. Wire: Fabricate from 6.35-mm-diameter, hot dip galvanized steel. Mill-galvanized wire ties may be used in interior walls, unless otherwise indicated.

D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; galvanized after fabrication.
2. Tie Section for Concrete: Metal ties with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 25 mm of masonry face.

E. Rigid Anchors/galvanized steel angles: Corrosion Protection Hot-dip galvanized to comply with ASTM A 153/A 153M, of dimensions as shown on drawings or required by the Engineer.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Joint Sealants: Comply with Division 7, Section “Joint Sealant”.

E. Fire rated joint sealant: shall be as specified in Division 7, Section “Through Penetration fire stop systems”.

F. Compressible filler: In joint between top of partition and underside of structure above use compressible filler as recommended by manufacturer and approved by the Engineer.

G. Backing rod: polyethylene foam backing tube (hollow core) for joints at concrete masonry wall head.

H. Sealant in non fire-rated masonry walls: Two part polysulphide sealant to BS 4254 or ASTM C920: consisting of polysulphide polymer with selected additives mixed to form a tough, flexible durable rubber like material.

- Shore A hardness: 25 at 25°C.
- Movement accommodation factor: ±25%.

I. Sealant in fire-rated masonry walls: As a fire rated joint sealant in fire rated masonry walls, use elastomeric silicone sealants to comply with a UL-listed joint system or tested to BS 476 at head of wall.

2.8 MASONRY CLEANERS

A. Proprietary Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other stains from new and existing masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

B. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

1. Comply with ASTM C 270 Property Specification Wet mix life: <1.5 hours
2. Initial adhesion at 28 days:> 0.3N/mm2

3. Testing: ASTM C 780

C. Mortar for Unit Masonry: Comply with ASTM C 270 Property Specification. Compressive strength of mortar after 28 days shall not exceed the compressive strength of concrete masonry units, but shall not be less than 5 MPa. Submit laboratory design mix for approval.

D. Grout for Unit Masonry: Comply with ASTM C 476. Unless otherwise specified, use grout of consistency indicated or, if not otherwise indicated, of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1 / ASCE 6 / TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 200 to 280mm as measured according to ASTM C 153 / C 143M.
3. Concrete grout shall be used for filling hollow cells in bond beams, under concrete lintels and bond beams, in window and door jambs, in column, and other locations for reinforced masonry assemblies as specified.
4. Mortar and Grout shall be mechanically mixed in drum mixers in volumetric proportions with only enough water shall be added to the mixture to produce a mixture which is flowable, but which will not show an excess of water when placed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. For the record, prepare written report, listing conditions detrimental to performance.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.2 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible.

B. Walls which are left unplastered (if any) shall have a fair-faced finish consisting of selected blocks pointed with a neat flush joint as work proceed.

C. Thickness: Build composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.

D. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.

E. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.

F. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

G. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

3.3 CONSTRUCTION TOLERANCES

A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:

1. For dimensions in cross section or elevation do not vary by more than plus 12 mm or minus 6 mm.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 12 mm.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 6 mm in a story height or 12 mm total.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 3 mm in 3 m, 6 mm in 6 m or 12 mm maximum.
5. For vertical alignment of exposed head joints, do not vary from plumb by more than 6 mm in 3 m, or 12 mm maximum.
6. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 3 mm in 3 m, 6 mm in 6 m, or 12 mm maximum.
7. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 3 mm, with a maximum thickness limited to 12 mm. Do not vary from bed-joint thickness of adjacent courses by more than 3 mm.
8. For exposed head joints, do not vary from thickness indicated by more than plus or minus 3 mm. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 3 mm.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Lay exposed masonry in the bond pattern indicated. Do not use units with less than nominal 100 mm horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 50 mm. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 100 mm horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: In each course, rack back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.

F. Fill space between frames and masonry solidly with mortar, unless otherwise indicated.

G. Where built-in items are to be embedded in cores of solid masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

H. Fill cores in solid concrete masonry units with grout 600 mm under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.

1. Install expanded metal lath at interface between top of partition and underside of structure above, nailed to slab at 800mm.
2. Install compressible filler in joint between top of partition and underside of structure above.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated walls or partitions, install firestopping joint filler as specified in this Section in joint between top of partition and underside of structure. Fill joints at both faces with fire rated elastomeric silicone sealants to comply with a UL-listed joint system at head of wall. Comply with requirements of Division 7, Section “Joint Sealants”.

3.5 MORTAR BEDDING AND JOINTING

A. Lay masonry units as follows:

1. With full mortar coverage on horizontal and vertical face shells.
2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.

C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Provide 1000 mm expanded metal lath masonry joint reinforcement every two courses in the locations indicated below.

1. At connection with concrete columns poured prior to masonry.
2. At intersecting masonry blocks forming a corner.

3.7 LINTELS, JAMBS, COLUMNS AND BEAMS

A. Provide lintels, doors jambs, columns and beams as indicated on the drawings.

B. For formwork, reinforcing steel and concrete installation, refer to Division 3 Section “Cast-In-Place Concrete”.

3.8 FIRE RATED MASONRY ASSEMBLIES

A. Fire Rating of solid block masonry: As indicated on Drawings.

B. Thickness: As required to satisfy fire rating indicated but not less than thickness indicated on Drawings.

C. Unit Type: As required to satisfy fire rating indicated in compliance with requirements specified in this Section.

D. Care shall be exercised to solidly fill all joints, vertical and horizontal, with mortar.

E. Joints: To structure above or adjoining are to be prefabricated, fire rated joint system comprising fire rated compressible filler and fire rated joint sealant on each face of the assembly, labeled by UL as rated for fire rating indicated.

F. Penetrations through fire rated masonry walls shall be sealed and treated with material systems as specified in Division 7, Section “Through Penetration Fire Stop Systems”.

G. Where required, expansion joints through fire rated concrete masonry walls or at the intersection between concrete masonry walls and other walls or partition shall be 60 or 120 minutes fire rated construction. Use firestop joint filler as specified in this Section and fire rated joint sealant on each face of the assembly. Comply with Division 7, Section “Joint Sealants”.

H. All accessories used in construction of fire rated assemblies shall be certified as suitable for use in fire rated masonry assemblies of rating indicated.

3.9 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural member to comply with the following:

1. Provide an open space not less than 13mm, 25mm in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.

2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 610mm o.c. vertically and 915mm o.c. horizontally.

3.10 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joints in unit masonry where indicated. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

B. Form control joints in concrete masonry as follows:
   1. Install preformed control-joint gaskets designed to fit standard sash block.

C. Form expansion joints in brick made from clay or shale

D. Build in horizontal, pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified.

3.11 FIELD QUALITY CONTROL

A. Engage a qualified independent testing agency to perform field quality-control testing indicated below.

B. Testing Frequency: Tests and Evaluations listed in this Article will be performed during construction for each 465 sq. m of wall area or portion thereof.

C. Mortar properties will be tested per ASTM C 780.

D. Grout will be sampled and tested for compressive strength per ASTM C 1019.

E. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.

F. Prism-Test Method: For each type of wall construction indicated, masonry prisms will be tested per ASTM C 1314, and as follows:

   Prepare 1 set of prisms for testing at 7 days and 1 set for testing at 28 days.

3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.

SECTION 055000 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes but not limited to the following:

1. Cast iron steel sockets
2. Bollards.
3. Handrail
4. Ladder
5. Fence
6. Cover to water tank.
7. Sump pit cover.
8. Steel trench covers.
9. Canopy
10. Miscellaneous framing and supports.
11. Miscellaneous metal trim.
12. Galvanized steel louvers to technical and wherever required.

B. Related Sections include the following:

1. Division 5 Section “Metal Gratings”.
2. Division 5 Section “Structural Steel Framing”.
3. Division 5 Section “Pipe and Tube Railings”.
4. Division 8 Section “Glazing”
5. Division 9 Section “High-Performance Coatings”.

1.3 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night time sky heat loss:

1. Temperature Range: 35 deg C ambient; 65 deg C material surfaces.

1.4 SUBMITTALS

A. Submittals Procedures: Submit the following according to Conditions of the Contract.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

C. Product Data: For the following:

1. Paint products.
2. Grout.

D. Design calculations for steel elements subjected to loads for Engineer approval.

E. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

F. Templates for anchors and bolts specified for installation under other Sections.

G. Welding Certificates: Copies of certificates for welding procedures and personnel.

H. Warranty: The Contractor shall provide a warranty of materials and workmanship for all metal fabrication works, provided under this Contract for a period of minimum 10 years from the date of Taking Over Certificate of the whole of the Works.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel".
2. AWS D1.2 "Structural Welding Code -- Aluminium".
3. AWS D1.3 "Structural Welding Code -- Sheet Steel".
4. AWS D1.6 "Structural Welding Code -- Stainless Steel".

1.6 PROJECT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Provide allowance for trimming and fitting at site.

1.7 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor

bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. ArcelorMittal;

B. Metalinox;

C. Approved equal.

2.2 METALS, GENERAL

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, rollers marks, rolled trade names, blemishes or roughness.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 316.

C. Stainless-Steel Bars and Shapes: ASTM A276, Type 316.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786 M rolled from plate complying with ASTM A 36/A 36M or ASTM A 283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A793.

F. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.

G. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads. Welded Type.

H. ASTM A792/A792M: Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

I. Malleable-Iron Castings: ASTM A 47M, Grade 22010.

J. Gray-Iron Castings: ASTM A48, class 30 (ASTM A 48M, Class 200), unless another class is indicated or required by structural loads.

K. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

L. Welding Rods and Bar Electrodes: Select according to AWS specifications for metal alloy welded.

M. Welding to Stainless steel by Argon type Electrode welding.

N. Wire Mesh: 3.4mm diameter inner crimped steel wire woven into 38 diamond mesh. Wire mesh is to comply with ASTM A853. Wire mesh finish is to be regular zinc coated.

2.4 ROLLED STEEL FLOOR PLATES (STEEL CHEQUERED PLATES)

A. Rolled steel floor plates (steel chequered plates) are to be ASTM A786M carbon alloy steel rolled floor plates fabricated from ASTM A283 plates for plates to be bent or cold formed and ASTM A36 plates for straight applications, raised pattern, diamond-shaped, unless otherwise other shape is specified or selected by the Engineer, thickness as indicated on Drawings but not less than 6mm. Finish is to be hot-dip galvanize after fabrication.

2.5 STAINLESS STEEL SECTIONS:

A. Grade: 316

B. Standard: ASTM A 666, and ASTM A 167

C. Thicknesses, sizes and dimensions: as shown on drawings and details.

D. Finishes: to the selection of the engineer.

E. All fixation elements; plates, gussets, sections, anchors, bolts, fasteners and the like should be made of same material as the whole system, i.e. Stainless steel grade 316, unless otherwise specified.

2.6 GALVANIZED STEEL SECTIONS

A. Type: Hot Dip Galvanized Steel

B. Standard: ASTM A 123

C. Thicknesses, sizes and dimensions: as shown on drawings and details.

D. Finishes: Powder coating, of colors and finishes to the selection of the engineer.

E. All fixation elements; plates, gussets, sections, anchors, bolts, fasteners and the like should be made of same material as the whole system, i.e. Hot Dip Galvanized, unless otherwise specified.

F. Refer to Section “099600” High Performance Coating”

2.7 ALUMINUM

A. Aluminum Plate and Sheet: ASTM B209 (ASTM B 209 M), alloy 6061 – T6.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221 M), alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, alloy 6061-T6.

2.8 PAINT

A. General: Refer to Division 9 Section “High-Performance Coatings” for metal coating.

B. Shop Primers: Provide epoxy zinc rich primers that comply with SSPC – Paint 20 or SSPC – Paint 29 and compatible with top coat specified in primers that comply with Division 9 Section “Painting”.

C. Galvanizing Repair Paint: Epoxy high-zinc dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

D. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.9 FASTENERS

A. General: Unless otherwise indicated provide type 316 stainless-steel for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, for interior use and where built into exterior walls, unless otherwise shown on Drawings. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563 and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

D. Machine Screws: ASME B18.6.7M.

E. Lag Bolts: ASME B18.2.3.8M.

F. Wood Screws: Flat head, carbon steel, ASME B18.6.1.

G. Plain Washers: Round, carbon steel, ASME B18.22M.

H. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.2M.

I. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594 for exterior applications.

J. Toggle Bolts: FS FF-B 588, tumble wing type, class and style as needed.

2.10 GROUT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.11 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

I. Comply with details indicated on Drawings or approved shop drawings.

2.12 GALVANIZED STEEL LOUVERS

A. Provide 2mm thick galvanized steel louvers, including steel frames and sub-frames, steel sheets, plates, special anti-corrosion paint for steel elements, galvanized steel fly screen (wire

mesh), clip-in, sealant , paint and all necessary fixings and accessories as shown on drawings and details. RAL Color to be selected by the Engineer.

2.13 STAINLESS STEEL BOLLARDS

A. Type: Fixed Bollards.

B. Material: stainless steel grade 316, unless otherwise shown on Drawings.

C. Finish: brushed, to the approval of the Engineer.

D. Color: as selected by the Engineer.

E. Dimensions: circular diam. 114 mm and H: 1000 mm (raised height), unless otherwise shown on Drawings.

F. Fixed to concrete floor using fixation plate and anchor bolts with epoxy injection.

2.14 ALUMINUM STRIP PROTECTION WALL IN GARBAGE ROOM

A. Material: Aluminum, unless otherwise shown on Drawings.

B. Finish: Powder coated, to the approval of the Engineer.

C. Color: as selected by the Engineer.

D. Dimensions: as shown on Drawings or as per manufacture requirement and approved Engineer.

E. Fixed to concrete/masonry wall using all necessary fixing and accessories as per manufacturer recommendation.

2.15 GALVANIZED STEEL HANDRAIL

A. Material: Galvanized steel, unless otherwise shown on Drawings.

B. Finish: Powder coated, to the approval of the Engineer.

C. Color: as selected by the Engineer.

D. Dimensions: as shown on Drawings.

E. Fixed to concrete floor using fixation plate and anchor bolts with epoxy injection.

F. Fixed to concrete parapet as per manufacturer requirement and approval of the Engineer.

2.16 GALVANIZED STEEL FENCE

A. Material: Galvanized steel, unless otherwise shown on Drawings.

B. Finish: Powder coated, to the approval of the Engineer.

C. Color: as selected by the Engineer.

D. Dimensions: as shown on Drawings.

E. Fixed to concrete parapet as per manufacturer requirement and approval of the Engineer.

F. Galvanized steel Tubular 120 mm high and 3 mm thick and distributes as shown on drawing

2.17 GALVANIZED STEEL LADDERS

A. Material: Galvanized steel, unless otherwise shown on Drawings.

B. Finish: Powder coated, to the approval of the Engineer.

C. Color: as selected by the Engineer.

D. Dimensions: as shown on Drawings.

E. Fixed to concrete substrata as per manufacturer requirement and approval of the Engineer.

F. Galvanized steel Tubular tube 120 mm high and 3 mm thick unless otherwise noted or as shown on drawing

2.18 Canopy

A. Material: Galvanized steel, unless otherwise shown on Drawings.

B. Finish: Powder coated, to the approval of the Engineer.

C. Color: as selected by the Engineer.

D. Dimensions: as shown on Drawings.

E. Fixed to concrete substrata as per manufacturer requirement and approval of the Engineer.

F. Galvanized steel tension rod as per manufacturer requirement or as shown on drawing

G. Cover shall be safety glass16 mm unless otherwise noted and shall be as per manufacturer requirement and approved of the Engineer, Contractor shall be redesign and submit shop drawing to Engineer for approval on his own expanses.

2.19 SUMP PIT COVER

A. Provide cast iron cover to sump pits with dimensions and details as shown on the drawings. Provide cast iron frame, lifting keyholes, supports and accessories indicated and as necessary to complete the Work.

2.20 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports that are not a part of structural steel framework as necessary to complete the Work.

B. General: Provide steel framing and supports indicated and as necessary to complete the Work.

C. Fabricate units from structural steel shapes, plates and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes and profiles indicated and as necessary to receive hardware, hangers and similar items.

1. Where units are indicated to be cast in to concrete or built in to masonry, equip with integrally welded steel strap anchors 32mm wide by 6mm thick by 200mm long at 600mm o.c unless otherwise indicated.
2. Furnish inserts if units must be installed after concrete is placed.

D. Neoprene strip: suitable for supporting metallic covers and complying with ASTM standards.

2.21 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 150mm from each end, 150mm from corners, and 600mm o.c., unless otherwise indicated.

C. Galvanize miscellaneous steel trim in the following locations:

1. Exterior
2. Interior, where indicated.

2.22 ALIMINIUM LOUVERS

A. Unless otherwise indicated, install powder coated aluminium louvers including steel frames and subframes, steel sheets, plates, special anti-corrosion paint for steel elements, galvanized steel fly screen (wire mesh), aluminium clip-in, sealant and all necessary fixings and accessories as shown on drawings and details. RAL Color to be selected by the Engineer.

2.23 ALUMINUM FRAMING

A. Fabricate from extruded aluminum sections.

B. Joints are to be mechanical.

2.24 FINISHES, GENERAL

A. Comply with requirements of Division 9, Section “High-Performance Coatings” for applying of finishes indicated on drawings.

B. Finish metal fabrications after assembly.

2.25 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
3. ASTM A 653/A 653M, Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. Preparation for shop priming: prepare uncoated ferrous-metal surfaces to comply with requirements specified in Division 9, Section “Painting”.

C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finished and those to be embedded in concrete or masonry, unless otherwise indicated.

D. Field-Applied Finishes: Type of finish is to be as indicated on Drawings or specified. Comply with requirements of Division 9, Section “Painting” for type of finish indicated.

2.26 STAINLESS STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Brushed finish No. 4.

C. When finishing is completed, passive and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.27 ALUMINUM FINISHES

A. Concealed Surfaces: Finish as follows:

Mechanical: non specular, as fabricated
Chemical: etched, medium matt.

B. Exposed Surfaces: Finish as follows:

Mechanical: non specular, as fabricated
Chemical: etched, medium matt.
Anodic Coating where required: clear, Class 1, 18-micron minimum thickness.
Normal electrostatic powder coating where required: two coats 40-60 microns as per manufacturer’s instructions.
PVDF electrostatic powder coating where required: two coats 30-50 microns as per manufacturer’s instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for

concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabricators accurately in location, alignment, and elevation; with edges and surfaces level, plumb, tree, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood or dissimilar metals with heavy coat of bituminous paint.

3.2 SETTING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout, in exposed locations, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLATION MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.

3.4 INSTALLING BOLLARDS

A. Anchor bollards to existing construction with anchor bolts. Provide four 19-mm bolts at each bollard, unless otherwise indicated.

   1. Embed anchor bolts at least 100mm in concrete.

B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 3mm toward bollard.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   1. Apply by brush or spray to provide a minimum 0.05-mm dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting".

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes the following:

1. Stainless Steel pipe and tube handrails.
2. Steel pipe and tube handrails with anti-corrosion paint.
3. Galvanized Steel sections with Powder coating (where indicated).

B. Related Sections include the following:

1. Division 5 “Metal Fabrication”.
2. Division 5 “Structural Steel Framing”.
3. Division 9 “High-Performance Coatings”.

1.3 PERFORMANCE REQUIREMENTS

A. General: In engineering handrails to withstand structural loads indicated, determine allowable design working stresses of handrail materials based on the following:

1. Structural Steel: AISC S335, "Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design with Commentary."
2. Cold-Formed Structural Steel: AISI SG-673, Part I, "Specification for the Design of Cold-Formed Steel Structural Members."

B. Structural Performance of Handrails: Provide handrails capable of withstanding the following structural loads without exceeding allowable design working stresses of materials for handrails, anchors, and connections:

1. Handrails Not Serving As Top Rails: Capable of withstanding the following loads applied as indicated:
   a. Concentrated load of 890 N applied at any point and in any direction.
   b. Uniform load of 730 N/m applied in any direction.
   c. Concentrated and uniform loads above need not be assumed to act concurrently.

C. Thermal Movements: Provide handrails that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other

detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 35 deg C, ambient; 65 deg C, material surfaces.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected handrails.
2. Grout, anchoring cement, and paint products.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Show fabrication and installation of handrails. Include plans, elevations, sections, component details, and attachments to other Work.

1. For installed handrails indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for products with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, prepared on components indicated below and of same thickness and metal indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1. 150-mm- long sections of each handrail.
2. Fittings and brackets.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and Employers, and other information specified.

G. Product Test Reports: From a qualified testing agency indicating products comply with requirements, based on comprehensive testing of current products.

H. Submit certified mill test reports covering the chemical analysis and physical properties for each type of steel used in the work.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

B. Source Limitations: Obtain each type of handrail through one source from a single manufacturer.

C. Mockups: Before installing handrails, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location as directed by the Engineer.
2. Build mockups for each form and finish of handrail with anchorage system components that are full height and are not less than 600 mm in length.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Notify the Engineer seven days in advance of dates and times when mockups will be constructed.
5. Obtain the Engineer's approval of mockups before fabricating handrails.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 STORAGE

A. Store handrails in a dry, well-ventilated, weather-tight place.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify handrail dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 COORDINATION

A. Coordinate installation of anchorages for handrails. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the Project site in time for installation.

1.9 SCHEDULING

A. Schedule installation so handrails are mounted only on completed walls. Do not support temporarily by any means that does not satisfy structural performance requirements.

1.10 WARRANTY

A. Special Warranty: Submit a written warranty, by the manufacturer and the Contractor, for metal finish and coatings that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Ten years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Arcelor Mittal, or approved equal.

B. Metalinox;

C. Approved equal.

2.2 METALS IN GENERAL

A. General: Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.

1. Castings: ASTM B 26/B 26M, alloy A356-T6.

B. Steel and Iron: Provide steel and iron in the form indicated, complying with the following requirements:

1. Steel Pipe: ASTM A 53; finish, type, and weight class as follows:

d. Black finish, unless otherwise indicated.

e. Galvanized finish where indicated.

f. Type F, or Type S, Grade A, standard weight (Schedule 40), unless another grade and weight are required by structural loads.

2. Steel Tubing: Cold-formed steel tubing, ASTM A 500, Grade A, unless another grade is required by structural loads.

3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

4. Iron Castings: Malleable iron complying with ASTM A 47M, Grade 22010.

5. Bolts: galvanized steel bolts, Hilti or approved equal.

C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

D. Stainless steel grade 316, as per ASTM A666 and ASTM A167

E. Fittings, Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

1. For Welded Assemblies: Provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

2. For Mechanical Assemblies: Provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

2.3 Handrails and Guardrails:

A. Type 1: Stainless steel

1. Grade: 316

2. Standard: ASTM A 666, and ASTM A 167
3. Thicknesses, sizes and dimensions: as shown on drawings and details.
4. Finishes: to the selection of the engineer.
5. All fixation elements; plates, gussets, sections, anchors, bolts, fasteners and the like should be made of same material as the whole system, i.e. Stainless steel grade 316, unless otherwise specified.

B. Type 2: Steel with Anti-corrosion Protection Paint

1. Type: Steel
2. Thicknesses, sizes and dimensions: as shown on drawings and details.
3. Finishes: Anti-corrosion paint, of colors and finishes to the selection of the engineer.
4. All fixation elements; plates, gussets, sections, anchors, bolts, fasteners and the like should be Hot Dip Galvanized, unless otherwise specified.
5. Refer to Section “099600” High Performance Coating”

C. Type 2: Galvanized Steel

1. Type: Hot Dip Galvanized Steel
2. Standard: ASTM A 123
3. Thicknesses, sizes and dimensions: as shown on drawings and details.
4. Finishes: Powder coating, of colors and finishes to the selection of the engineer.
5. Intumescent protective coating wherever required.
6. All fixation elements; plates, gussets, sections, anchors, bolts, fasteners and the like should be made of same material as the whole system, i.e. Hot Dip Galvanized, unless otherwise specified.
7. Refer to Section “099600” High Performance Coating”

2.4 WELDING MATERIALS, FASTENERS, AND ANCHORS

A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Fasteners for Anchoring Handrails to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails to other types of construction indicated and capable of withstanding design loads.

C. Use special type of welding (Argon Electrode welding) for Stainless steel sections

1. For steel handrails and fittings, use plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

D. Fasteners for Interconnecting Handrail Components: Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

1. Provide concealed fasteners for interconnecting handrail components and for attaching them to other work, unless otherwise indicated.

2. Provide flat-head machine screws for exposed fasteners, unless otherwise indicated.

E. Cast-in-Place and Postinstalled Anchors: Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Chemical anchors.
2. Expansion anchors.

2.5 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION

A. General: Fabricate handrails to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble handrails in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail components.

D. Welded Connections: Fabricate handrails for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

E. Nonwelded Connections: Fabricate handrails by connecting members with concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive where this is manufacturer's standard splicing method.

F. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail members to other work, unless otherwise indicated.

G. Provide inserts and other anchorage devices for connecting handrails to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails. Coordinate anchorage devices with supporting structure.

H. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

I. Ease exposed edges to a radius of approximately 1 mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

J. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

K. Provide weep holes or another means to drain entrapped water in hollow sections of handrail members that are exposed to exterior or to moisture from condensation or other sources.

L. Fabricate joints that will be exposed to weather in a watertight manner.

M. Close exposed ends of handrail members with prefabricated end fittings.

N. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of railing and wall is 6 mm or less.

O. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Provide exposed fasteners with finish matching appearance, including color and texture, of handrails.

2.8 STEEL FINISHES

A. Refer to Division 9 “High-Performance Coatings”.

B. Steel handrails components to be anti-corrosion protected.

C. Polyester Powder Coating: approved type to meet the requirements of AAMA 603 consisting of powder particles of resinous material and additives to improve performance. The coating is to be electrostatically sprayed on the object to produce produces a hard, durable coating:

1. Minimum Dry Film Thickness: 80 microns.
2. Color and surface finish: as shown on Drawings or selected by Engineer.

D. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

E. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

F. For galvanized handrails, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

G. For nongalvanized steel handrails, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

H. Preparation for Shop Priming: After galvanizing, thoroughly clean handrails of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.

I. Apply shop primer to prepared surfaces of handrail components, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required to install handrails. Set handrails accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

1. Do not weld, cut, or abrade surfaces of handrail components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 2 mm in 1 m.
3. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 5 mm in 3 m.

C. Adjust handrails before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and for properly transferring loads to in-place construction.

3.3 ATTACHING HANDRAILS TO WALLS

A. Attach handrails to wall with wall brackets. Provide bracket with 40-mm clearance from inside face of handrail and finished wall surface.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.

3.4 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.5 PROTECTION

A. Protect finishes of handrails from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

SECTION 055300 – METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Cast iron gutter gratings.
2. Metal bar gratings.
3. Metal frames and supports for gratings.
4. All necessary fixings and accessories necessary for the complete installation of the cast iron gratings.

B. Related Sections include the following:

1. Division 5 Section “Metal Fabrication”.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide gratings capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections:

1. Floors: Capable of withstanding the following loads
   a. For heavy duty road gratings, a wheel load of 128 kN, minimum test load 350 kN.
   b. For medium duty gratings inside buildings and car parks, a wheel load of 9 kN, minimum test load 245 kN.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Formed-metal plank gratings.
2. Clips and anchorage devices for gratings.
3. Paint products

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Show fabrication and installation details for gratings. Include plans, elevations, sections, and details of connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Verification: For each profile and pattern of fabricated metal and for each type of metal finish required, prepared on metal of same thickness and alloy indicated for the Work. If finishes involve normal color and texture variations, include sample sets, consisting of two or more units, showing the full range of variations expected.

E. Welding Certificates: Copies of certificates for welding procedures and personnel, under the “Quality Assurance” article.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.

G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing gratings similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Engineering Responsibility: Engage a fabricator who utilizes a qualified structural engineer to prepare design calculations, shop drawings, and other structural data.

C. Metal Bar Grating Standards: Comply with applicable requirements of the following:

1. Non-Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."

2. Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual." or EN 124.

D. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.3, "Structural Welding Code--Sheet Steel."

3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.6 PROJECT CONDITIONS

A. Field Measurements: Where gratings are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.7 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of Metal Grating components those fail in performance, materials, or workmanship within specified warranty period.

B. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Meiser Vogland OHG;

B. Fonderies Ohanes H. Kassardjian;

C. Saudi Cast;

D. Or approved equal.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Hot dip galvanized steel sections and elements complying with ASTM A 123.

C. Wire Rod for Grating Crossbars: ASTM A 510M.

D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy to be welded.

E. Steel Bars for Gratings: ASTM A 569M or ASTM A 36M.

F. Stainless-Steel Bars and Shapes (wherever required): ASTM A 276, Type 316.

G. Gray-Iron Castings: ASTM A48, class 30 (ASTM A 48M, Class 200), unless another class is indicated or required by structural loads.

2.3 GALVANIZED STEEL SECTIONS (wherever required)

A. Type: Hot Dip Galvanized Steel

B. Standard: ASTM A 123

C. Thicknesses, sizes and dimensions: as shown on drawings and details.

D. Finishes: Powder coating, of colors and finishes to the selection of the engineer.

E. All fixation elements should be made of same material as the whole system, i.e. Hot Dip Galvanized, unless otherwise specified.

F. Refer to Section “099600” High Performance Coating”

2.4 FASTENERS

A. General: Provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, for interior use. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM F 568M, Property Class 4.6; with hex nuts, ASTM A 563M; and, where indicated, flat washers.

C. Plain Washers: Round, carbon steel, ASME B18.22M.

D. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.2M.

E. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.5 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Ease exposed edges to a radius of approximately 1 mm, unless otherwise indicated.

E. Fit exposed connections accurately together to form hairline joints.

F. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

2.6 TRENCH COVER GRATINGS

A. Cast iron grating, heavy duty type. Furnish complete with galvanized steel frame of welded slotted anchors for embedding into adjoining concrete and with 5mm thick continuous neoprene strips.

2.7 METAL BAR GRATINGS

A. Medium and heavy duty gratings manufactured from Hot-dip galvanized steel. Bearing bars and cross bars are to be of rectangular section with size and spacing as per manufacturer's written recommendation for the span and type of loading indicated on the drawings. Cross bars are to be locked at right angles to and in the same plane as, the top surface of bearing bars. Properties shall be as follows:

1. Grating Mark: As indicated, but with bearing bar size not less than that required to comply with structural performance requirements.
2. Type: welded pressure locked.
3. Traffic Surface for steel Bar Gratings: serrated.
4. Steel Finish: Hot-dip galvanized with a coating weight of not less than 550 g/sq.m. of coated surface.
5. Cut Outs: Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrations gratings.
6. Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
    a. Provide not less than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
    b. Furnish threaded bolts with nuts and washers for securing grating to support.
7. Form: Furnish in form of removable panels of suitable sizes.

2.8 GRATING FRAMES AND SUPPORTS

A. Steel Frames and Supports: Fabricate from structural-steel shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

B. Equip units with integrally welded anchors for casting into concrete or building into masonry.

1. Unless otherwise indicated, space anchors 600 mm o.c. and provide minimum anchor units in the form of steel straps 32 mm wide by 6 mm thick by 200 mm long.

C. Galvanize frames and supports after fabrication and shop paint with epoxy primer and epoxy high build coating.

2.9 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

C. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with ASTM A 123.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed items:

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

E. Apply shop primer to uncoated surfaces of gratings, frames, and supports, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are the same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 0.05-mm dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. MDF Panels with Artificial Veneer (Formica).
2. Counters
3. Countertop
4. Wooden backing.
5. Wooden light boxes.
6. Wooden Sub-frames.
7. Closets and Cabinets
8. All necessary fixings, supports and accessories as shown on drawings and details and as required by the engineer.
9. All other wooden works, as shown on drawings and details.
10. Refer to the finishing schedule and to the related drawings and details.

B. Related Sections include the following:

1. Division 8 Section "Flush Wood Doors".
2. Division 9 Section "Interior Painting".

1.3 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items, unless concealed within other construction before woodwork installation.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including hardwares and accessories, handrail brackets, and finishing materials and processes.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, and other items installed in architectural woodwork.
4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.

D. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.

1. Shop-applied transparent finishes.
2. Shop-applied opaque finishes.
3. Solid-surfacing materials.

E. Samples for Verification: For the following:

1. Lumber and panel products with shop-applied opaque finish, 300 sq. cm for lumber and 200 by 250 mm for panels, for each finish system and color, with 1/2 of exposed surface finished.

F. Product Certificates: Signed by manufacturers of woodwork certifying that products furnished comply with requirements.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.

H. Warranty: For materials and workmanship, 10 years period from the date of Taking over certificate of the whole of the works.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed architectural woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Fabricator Qualifications: A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production and installation of interior architectural woodwork with

sequence-matched wood veneers including wood doors where veneer matching includes door faces.

D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork, construction, finishes, and other requirements.

1. Provide AWI certification labels or compliance certificate indicating that woodwork complies with requirements of grades specified.
2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with such selections and requirements in addition to the quality standard.

E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

F. Mockups: Before fabricating and installing interior architectural woodwork, build mockups for each form of construction and finish required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Engineer.
2. Notify Engineer seven days in advance of dates and times when mockups will be fabricated and installed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Engineer's approval of mockups before starting interior architectural woodwork fabrication.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. List of Abbreviations:

1. DOC PS 1: U.S. Department of Commerce, National Institute of Standards and Technology; Product Standards (PS): Softwood Lumber and Plywood Standards “Construction and Industrial Plywood”.
2. AWI: Architectural Woodwork Institute.
3. AWPA: American Wood Preservers Association.
4. GANA: Glass Association of North America.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 8 Section "Door Hardware" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Wood Species and Cut for Transparent Finish: as indicated on drawings.

C. Wood Species for Opaque Finish: as indicated on drawings.

D. Wood Products: Comply with the following:

1. Hardboard: American Hardboard Association: AHA A135.4.
2. Medium-Density Fiberboard: ANSI A208.2, Grade MD-Exterior Glue
3. Softwood Plywood: DOC PS 1, Medium Density Overlay
4. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP –1, made with adhesive containing no urea formaldehyde.

E. Block board: shall conform to BS 3444 and made up of a core of rectangular softwood strips glued and bonded together under high pressure. The strips shall be placed edge to edge and sandwiched between veneers of hardwood. The sandwich shall be glued under high pressure. Place softwood strips or veneers at the edges.

1. Density: 450~500Kg/m³.
2. Moisture Content: 10~12%.

F. Metal Supports and Reinforcement:

1. Steel Subframe Members: ASTM A 36, structural-quality steel members as required for support and reinforcement.

G. Artificial Veneer to MDF Panels/Partitions: Formica decorative laminate shall be high pressure laminated in pressing operation using a thermosetting adhesive.

1. Thickness: 0.6mm

H. Exposed panels to cabinets and cupboards shall be melamine faced as selected by the Engineer, premium grade complying with AWI section 300.

I. Rockwool: refer to Division 7 Section “Thermal Insulation”

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where indicated, use materials impregnated with fire-retardant chemical formulations indicated by a pressure process or other means acceptable to authorities having jurisdiction to produce products with fire-test-response characteristics specified.

1. Do not use treated material that does not comply with requirements of referenced woodworking standard or that is warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with AWPA C20 (lumber fire rated) and AWPA C27 (plywood fire rated), for woodwork items indicated as fire-retardant treated. Use the following treatment type:

1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln-drying.
2. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
3. Kiln-dry material before and after treatment to levels required for untreated material.

C. Fire-Retardant-Treated Lumber and Plywood by Nonpressure Process: Apply nontoxic, water-soluble, fire-retardant treatment by dip, spray, roller, curtain coating, vacuum chamber, or soaking to achieve flame-spread rating of 25 or less and smoke-developed rating of 450 or less per ASTM E 84.

D. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture

to achieve flame-spread rating of 25 or less and smoke-developed rating of 25 or less per ASTM E 84.

1. For panels 19 mm thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: density, 720-kg/cu. M; modulus of rupture, 11 MPa; modulus of elasticity, 2000 MPa; internal bond, 550 kPa; and screw-holding capacity on face and edge, 1100 N and1000 N, respectively.
2. For panels 20 to 32 mm thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: density, 705-kg/cu. m; modulus of rupture, 9 MPa; modulus of elasticity, 1700 MPa; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 780 N, respectively.

2.3 INSTALLATION MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.4 CUPBOARDS

A. Cupboards shall be made of moisture resistant 19 mm thick melamine faced MDF. The carcass to be finished with 2mm PVC tape edging applied by hot melt glued to make it waterproof.

B. Cupboards shall be mounted on anti-corrosion treated steel frame and shall not take direct load of the worktop.

C. Shelves of cupboards shall be moisture resistant 19 mm thick melamine faced MDF with 2mm PVC tape edging. They shall be adjustable for regular heights.

D. Back wall of Cupboard shall be 6mm melamine faced MDF.

2.5 MOISTURE RESISTANT HIGH PRESSURE LAMINATE CABINETS IN KITCHENS

A. High pressure laminated Cabinets.

1. Comply with AWI Section 400B – Laminate Clad Cabinets
2. Grade: Custom
3. AWI Type of Cabinet Face Construction: Flush overlay design unless otherwise indicated.
4. Panels: Cabinet panels shall be high-pressure decorative laminate over both sides of particleboard core.And shall be impact resistant, scratch, abrasion and wear resistant, heat resistant, completely water resistant, impervious to steam, chemical resistant and soaps and detergents shall not mildew.

5. Core: 22mm thick, Moisture Resistant Particle Board, ANSI A208.1, Type 1, Solid particle board manufactured of long fibered cuttings, bonded with water-resistant adhesive.

6. Adhesive: Thermosetting resin type.

7. All decorative laminate shall be to the Engineer's selection

B. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:

1. Horizontal Surfaces Other Than Tops: Grade HGS.

2. Postformed Surfaces: Grade HGP.

3. Vertical Surfaces: Grade HGS.

4. Laminate thickness: minimum 0.9mm.

5. Edges (Cabinet door and drawer edges): 3 mm-thick PVC banding, machine applied and trimmed, matching laminate in color, pattern, and finish.

C. Materials for Semi-exposed Surfaces:

1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS .

Edge (Cabinet body edges and shelf edges): 1 mm-thick PVC banding, machine applied and trimmed, matching laminate in color, pattern, and finish.

For semi-exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.

2. Drawer Box

13mm thick Melamine faced particleboard sides, back, sub-front, and bottom, with bottom screwed directly to the assembled drawer box.

All drawer box surfaces (excluding edges) to be finished with thermally fused melamine laminate.

Top edge of drawer box finished with 1mm PVC banding, machine applied and trimmed, matching laminate in color, pattern, and finish.

3. Laminate thickness: minimum 0.9mm.

2.6 FABRICATION, GENERAL

A. Interior Woodwork Grade: Provide Premium grade interior woodwork complying with the referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Engineer seven days in advance of the dates and times woodwork fabrication will be complete.

2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of openings in countertops with a coat of varnish.

G. Install glass to comply with applicable requirements in Division 8 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

2.7 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Quality Standard: Comply with AWI Section 300.

B. Grade: Premium.

C. For trim items wider than available lumber, use veneered construction. Do not glue for width.

D. For rails wider or thicker than available lumber, use veneered construction. Do not glue for width or thickness.

E. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

F. Assemble casings in plant except where limitations of access to place of installation require field assembly.

G. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.

H. Wood Species and Cut: Provide samples to Engineer for approval based on Drawings, schedules and Division 9 Section “Finish Data Sheets”.

2.8 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 8 Section Door Hardware”.

B. Butt Hinges: 70mm, 5- knuckle steel hinges made from 2.4mm thick metal, and as follows:

1. Semi-concealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semi-concealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Back-Mounted Pulls: BHMA A156.9, B02011.

D. Catches: Magnetic catches, BHMA A156.9, B03141.

E. Adjustable shelf standards and supports: BHMA A156.9, B04071; with shelf rests, B04081.

F. Drawer Slides: BHMA A156.9, B05091.

1. Heavy Duty Grade (Grade 1HD-100 and Grade 1HD-200): Side mounted, full-extension type; zinc plated steel ball-bearing slides.

G. Door Locks: BHMA A156.11, E07121.

H. Drawer Locks: BHMA A156.11, E07041.

I. Exposed Hardware Finishes: for exposed hardware, provide finish that complies with BHMA A156.18 for finish number to be selected by the Engineer.

J. For Concealed Hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.9 COUNTERTOP

A. Countertop resin Corian as per manufacturer requirement and approved of the Engineer.

2.10 COUNTER DESK

A. Factory manufactured counter desk shall be manufactured of composite element marble and wood as per drawing details.

B. 4 mm thick plywood board and paint with timber supported,

C. Finish Color: To be as directed by the Architect/Engineer.

D. Dimensions and size: As shown on drawings

PART 3 - EXECUTION

3.1 PREPARATION

A. Condition woodwork to average prevailing humidity conditions in installation areas before installation.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back priming.

3.2 INSTALLATION

A. Quality Standard: Install woodwork to comply with AWI Section 1700 for the same grade specified in Part 2 of this Section for type of woodwork involved.

B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 3 mm in 2400 mm.

C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.

D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with recommendations of chemical treatment manufacturer, including those for adhesives used to install woodwork.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches 1500 mm, long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.

1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base, if finished.
2. Install wall railings on indicated metal brackets securely fastened to wall framing.
3. Install standing and running trim with no more variation from a straight line than 3 mm in 2400 mm.

G. Complete the finishing work specified in this Section to extent not completed at shop or before installation of woodwork. Fill nail holes with matching filler where exposed. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats were applied in shop.

H. Refer to Division 9 Sections for final finishing of installed architectural woodwork.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. Section Includes:

1. Single-component polyurethane waterproofing applied to floor of wet areas and water channels.
2. Other locations for PU waterproofing, as required by the engineer

1.3 SUBMITTALS

A. Product Data: For type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

D. Samples: For the following products:

1. Flashing Sheet.
2. Waterproofing material applied on a surface representing actual substrate.
3. Membrane-reinforcing fabric, 300 by 300mm.

E. Qualification Data: For Installer.

F. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.

G. Field quality-control reports.

H. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is acceptable to waterproofing manufacturer for installation of waterproofing required for this Project.

B. Source Limitations: Obtain waterproofing materials from single source from single manufacturer.

C. Mockups: Before beginning installation, install waterproofing to 10 sq. m full area of building space that is specified to receive cold-applied waterproofing membrane to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality.

1. If the Engineer determines mockups do not comply with requirements, reapply waterproofing until mockups are approved.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Engineer specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 3 deg C above dew point.

1. Do not apply waterproofing in rain, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.7 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which waterproofing manufacturer agrees to repair or replace waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Warranty Period: Ten years from date of Taking Over Certificate of the whole of the Works.

B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering work of this section, for warranty period of ten years from date of Taking Over Certificate of the whole of the Works

1. Warranty includes removing and reinstalling all necessary works and materials, as required by the engineer.

PART 2 - PRODUCTS

2.1 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing for vertical surfaces application: Comply with ASTM C 836 and with manufacturer's written physical requirements.

1. Products: Subject to compliance with requirements:
   a. Carlisle Coatings & Waterproofing Inc or approved equal.
   b. DCP / Ayla Construction Chemicals.
   c. Sodap.
   d. or approved equal

B. Single-Component, Reinforced, Modified Polyurethane Waterproofing for horizontal surfaces application: Comply with ASTM C 836 and with manufacturer's written physical requirements.

1. Products: Subject to compliance with requirements:
   a. Carlisle Coatings & Waterproofing Inc.; CCW-525-H.
   b. DCP / Ayla Construction Chemicals.
   c. Sodap.
   d. or approved equal

C. Characterisics:

1. Tensile strength: 5N/mm², ASTM D412.
2. Elongation at break: 800%, ASTM D412.
3. Adhesion to concrete: 2.3 MPa, ASTM D903.
4. Hardness (shore A scale): 65, ASTM D2240

2.2 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.

B. Primer: Manufacturer's standard, factory-formulated polyurethane or epoxy primer.

C. Sheet Flashing: 1.3mm minimum, nonstaining, uncured sheet neoprene.

1. Adhesive: Manufacturer's recommended contact adhesive.

D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

E. Polyurethane mastic sealant at corners (wherever required by the engineer)

F. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, complying with ASTM C 920 Type M, Class 25; Grade NS for sloping and vertical applications or Grade P for deck applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.

1. Backer Rod: Closed-cell polyethylene foam.

G. Geotextile membrane: 200 g/m².

1. Refer to Division 7 Section " Ethylene-Propylene-Diene-Monomer (EPDM) Roofing".

H. Protection boards (wherever required):.

1. Refer to Division 7 Section " Ethylene-Propylene-Diene-Monomer (EPDM) Roofing".

I. Aluminium flashing and counter flashing:

1. Aluminum Sheet: ASTM B 209M, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:

2. Anodized Finish: Apply the following coil-anodized finish:

a. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as-fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating but 0.025 mm or thicker) complying with AAMA 611.

J. Gravel bed materials (wherever required).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.

2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

3.3 PREPARATION AT TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves according to ASTM C 898 and manufacturer's written instructions.

B. Prime substrate unless otherwise instructed by waterproofing manufacturer.

C. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

1. Provide sealant cants around penetrations and at inside corners of deck-to-wall butt joints when recommended by waterproofing manufacturer.

3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 898 and waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks, complying with ASTM D 4258, before coating surfaces.

1. Comply with ASTM C 1193 for joint-sealant installation.

2. Apply bond breaker between sealant and preparation strip.

3. Prime substrate and apply a single thickness of preparation strip extending a minimum of 75 mm along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.

B. Install a 250mm face, 45 degree cant of polyurethane sealant at all angle changes and inside corners including projections through the deck, wall, curbs, bumpers, etc…

C. All cracks over 1.6mm in width and all moving cracks under 1.6mm in width shall be saw cut to 6mm minimum in width and depth. Saw cut a 6mm by 6mm kerf around drain flanges. Clean, prime and fill saw cuts flush with polyurethane sealant.

D. Allow all sealant to cure thoroughly.

E. Apply a 150mm wide, 45mils thick stripe-coat of waterproofing centered over all sealed cracks, hairline cracks, joints and outside corners.

F. Install sheet flashing and bond to deck and wall substrates where indicated or required according to waterproofing manufacturer's written instructions.

1. Extend sheet flashings onto perpendicular surfaces and other work penetrating substrate according to ASTM C 898.

3.5 WATERPROOFING APPLICATION

A. Apply waterproofing according to ASTM C 898 and manufacturer's written instructions.

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate.

D. Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases, with an average dry film thickness of 60mils (1.5 mm).
2. Apply waterproofing to prepared wall terminations and vertical surfaces.
3. Verify wet film thickness of waterproofing every 10 sq. m.

E. In the event the entire surface is not completed in one day, prior to beginning application the next working day, clean an area of 150mm wide along the edge of the previously applied membrane with a cloth wet with xylene solvent. New work shall overlap the existing work by 150mm.

3.6 FIELD QUALITY CONTROL

A. Engage a full time site representative qualified by the waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, and application of the membrane, flashings, protection, and drainage components; and to furnish daily reports to the Engineer.

B. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

1. Flood to an average depth of 64 mm with a minimum depth of 25 mm and not exceeding a depth of 100 mm. Maintain 50 mm of clearance from top of sheet flashings.
2. Flood each area for 48 hours.

3. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

C. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

3.7 CURING, PROTECTION, AND CLEANING

A. Cure waterproofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.

1. Do not permit foot traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

SECTION **071613** - POLYMER MODIFIED CEMENT WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes modified cementitious waterproofing system to water tanks and where shown on drawings.

B. It includes also all related materials and accessories required for the complete installation for all waterproofing works.

C. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete".

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include data substantiating that materials comply with requirements, manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing. Submission shall be made complete and comprising all accessories and materials needed to complete the job.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for the Engineer’s approval.

C. Shop Drawings: For waterproofing system. Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Initial Selection: For each type of polymer-modified cement waterproofing indicated.

1. Include Samples of available color selection.

E. Samples for Verification: For each type of polymer-modified cement waterproofing indicated.

F. Qualification Data: For qualified Installer and manufacturer.

G. Submit a letter of certification from the manufacturer that certifies the waterproofing contractor is authorized to install the manufacturer's waterproofing system.

H. Product Certificates: For waterproofing, patching, and plugging materials, from manufacturer.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for each type of polymer-modified cement waterproofing.

J. Field quality-control reports.

K. Maintenance Data: For waterproofing system to include in maintenance manuals.

L. Warranties: Sample of special manufacturer’s warranties.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: A qualified firm that is approved, authorized, or licensed by waterproofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty, and should be experienced in applying polymer-modified cement waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain waterproofing materials through one source from a single manufacturer.

C. Comply with applicable regulatory requirements and applicable codes, ordinances, regulations and laws.

D. Mockups: Provide mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical vertical and horizontal surfaces shown on Drawings 1 sq. m in size to demonstrate surface preparation, crack and joint treatment, corner treatment, and execution quality.

2. Construct mockup in the location and of the size indicated or, if not indicated, as directed by Engineer.

3. Notify Engineer seven days in advance of dates and times when mockup will be constructed.

4. Obtain Engineer's approval of mockup before starting waterproofing.

5. If Engineer determines mockup does not comply with requirements, reapply waterproofing until mockup is approved.

6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.

7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver waterproofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture,

approval or listing agency markings, directions for storing , storing temperature, mixing with other components, and installation instructions. Deliver in sufficient quantity to permit work to continue without interruption

B. Comply with the manufacturer's written instructions for proper material storage.

C. Store materials containing solvents in dry, well ventilated spaces with proper fire and safety precautions. Keep lids on tight. Use before expiration of their shelf life.

D. Remove and replace materials that cannot be applied within their stated shelf life.

E. Any materials that are found to be damaged shall be removed and replaced at the Contractor's expense.

F. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit polymer-modified cement waterproofing to be performed according to manufacturer's written instructions and warranty requirements .

B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

1.7 WARRANTY

A. Special manufacturer's Warranty: Written manufacturer's warranty, in which manufacturer agrees to repair or replace components of waterproofing system that fail in materials within specified warranty period.

1. Warranty Period: min. Ten years from date of Taking Over Certificate of the whole of the Works.

B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering work of this Section, for warranty period of ten years from date of Taking Over Certificate of the whole of the Works.

C. Warranty includes removing and reinstalling materials related to the waterproofing system.

D. Failures include, but are not limited to, the following:

1. Failure to maintain watertight conditions within specified warranty period.

2. Bond failure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. There are no specific restrictions on manufacturers, Local and non-Local Suppliers, Sub-contractors, brands and countries of origin; acceptance criteria for all are compliance with required Contract specifications, and compliance with local codes and regulations

2.2 POLYMER-MODIFIED CEMENT-BASED WATERPROOFING

A. Prepackaged, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with polymer admixture to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, resists hydrostatic pressure and has properties meeting or exceeding the criteria specified below.

B. Polymer-modified cement waterproofing system shall be suitable for application in contact with potable water.

C. Water Permeability: Maximum zero for water at 9 m when tested according to CE CRD-C 48.

D. Compressive Strength: Minimum 30 MPa at 28 days when tested according to ASTM C 109/C 109M.

E. Flexural Strength: Minimum 5 MPa at 28 days when tested according to ASTM C 348.

F. Bond Strength: Minimum 1.5 MPa at 14 days when tested according to ASTM C 321.

G. Reduction in water absorption: 91.75 % according to ASTM D 870.

H. Elongation: 70 % according to ASTM D 412.

I. Color: As selected by the Engineer from full range.

2.3 ACCESSORY MATERIALS

A. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.

B. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.

C. Non-shrink mortar: type recommended by waterproofing manufacturer.

D. Fiber mesh reinforcement: type recommended by waterproofing manufacturer.

E. Portland Cement: ASTM C 150, Type I.

F. Slurry-Coat and Protective-Topping Sand: ASTM C 144.

G. Trowel-Coat Sand: ASTM C 33, fine aggregate.

H. Polymer Admixture for Protective Topping: Polymer bonding agent and admixture designed to improve adhesion to prepared substrates and to not create a vapor barrier.

I. Water: Potable.

2.4 MIXES

A. Prepackaged, Polymer-Modified Cement Waterproofing: Add prepackaged dry ingredients to mixing liquid according to manufacturer's written instructions. Mix together with mechanical mixer to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied. The substrate must be perfectly sound, clean, free from grease, oil, dust or any friable matters.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. Notify Engineer in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

A. Protect other work from damage from cleaning, preparation, and application of modified cement waterproofing. Provide temporary enclosure to confine spraying operation, and to ensure adequate ambient temperatures and ventilation conditions for application.

B. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

C. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.

D. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.

1. At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep. Fill reveal with patching compound flush with surface.

E. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces according to ASTM D 4258.
    a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
    b. Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
2. Clean concrete unit masonry surfaces according to ASTM D 4261.
    a. Lightweight Concrete Masonry: Etch with 10 percent muriatic (hydrochloric) acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
    b. Medium- and Normal-Weight Concrete Masonry: Sandblast or bushhammer
3. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

F. Corner Treatment: Comply with waterproofing manufacturer's written instructions to saw-cut corners and fill with non-shrink mortar recommended by the manufacturer.

3.3 APPLICATION

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water and maintain damp condition until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces indicated on Drawings.
3. Number of Coats: 3coats.
    a. Total Thickness: as recommended by waterproofing manufacturer, but not less than 2mm...
    b. Apply first coat as a slurry with brush or roller, and apply subsequent coats with brush, roller, spray, or trowel.
    c. Vigorously work first coat onto the substrate, forcing the material into surface voids. Apply each subsequent coat into full contact with previous coat.
    d. Allow manufacturer's recommended time between coats. Dampen surface between coats.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform inspections and to observe flood testing and examine for evidence of leaks during flood testing.

B. Flood Testing: Flood test waterproof system for leaks, according to ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

1. Flood to depth as directed by the Engineer.

2. Flood each area for 48 hours.

3. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

SECTION 075216 - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE WATERPROOFING

PART 4 - Part 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following waterproofing system area:

- Waterproofing system to buried elements:

1. SBS –modified bituminous membrane (double layer) to side and top of concrete sub-structure elements in contact with soil, with 5 mm protection board.
2. 5 mm thick, Protection board where needed
3. Aluminum powder coating cap flashing with fastener, Polyurethane sealant
4. All other related materials such as, Asphalt primer, mastic sealant metal flashing, angle fillet and the like.

B. Waterproofing system to Roof:

1. Surface preparation and leveling
2. Light weight concrete density 800 kg/m³ laid to slope (minimum 50 mm to maximum 150 mm)
3. Bituminous primer
4. SBS 4 mm thick –modified bituminous membrane (double layer) torch applied over primer coat to Roof areas.
5. Protection Board, 5 mm thick
6. Sika tiles with support and sealant as per manufacturer requirement and approved of the Engineer.
7. All other related materials such as, Asphalt primer, mastic sealant metal flashing, angle fillet and the like

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. Waterproofing System Design: Provide a waterproofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7.

1.4 SUBMITTALS

A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site. Data shall clearly indicate movement capability of cover assemblies and suitability of material used in exterior seals for UV exposure.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval

C. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions. Submit shop drawings for work specified herein for approval and obtain approval prior to fabrication and shipment of materials to the job site.

D. Samples for Verification: For the following products:

1. 300-by-300-mm square of waterproofing membrane sheet.
2. Flashing

E. Installer Certificates: Signed by waterproofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install waterproofing system.

F. Manufacturer Certificates: Signed by waterproofing manufacturer certifying that waterproofing system complies with specified requirements.

1. Submit evidence of meeting performance requirements.

G. Qualification Data: For Installer and manufacturer.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by an independent qualified testing agency, for components of waterproofing system.

I. Field quality-control reports

J. Maintenance Data: For waterproofing system to include in maintenance manuals.

K. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by waterproofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

B. Manufacturer Qualifications: A qualified manufacturer that has UL listing for waterproofing system identical to that used for this Project.

C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain waterproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

E. Mockups: Before beginning installation, install waterproofing to 10 sq. m full area of building space that is specified to receive waterproofing membrane to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality.

1. If the Engineer determines mockups do not comply with requirements, reapply waterproofing until mockups are approved.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Engineer specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver waterproofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing system manufacturer. Protect stored liquid material from direct sunlight.

C. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

D. Handle and store waterproofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit waterproofing system to be installed according to manufacturer's written instructions and warranty requirements.

B. Ventilation: Provide adequate ventilation during application of waterproofing in enclosed spaces. Maintain ventilation until waterproofing has cured

C. Humidity: do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 3 deg C above dew point

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of waterproofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

1. Special warranty includes waterproofing membrane, base flashings, waterproofing membrane accessories and other components of waterproofing system.

2. Warranty Period: 15 years from date of Taking Over Certificate of the whole of the Works.

B. Special Project Warranty: Submit waterproofing Installer's warranty, signed by Installer, covering Work of this Section, including all components of waterproofing system such as waterproofing membrane, base flashing, waterproofing membrane accessories and other components of waterproofing system for the following warranty period:

1. Warranty Period: 15 years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCT

2.1 SBS-MODIFIED ASPHALT-SHEET MATERIALS

A. waterproofing Membrane Sheet (Double layer): ASTM D 6162, Grade S, Type I or II, composite polyester- and glass-fiber-reinforced (180 gr/m2 reinforcement), SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified. Membrane technical specification as follows:

1. Description: SBS Elastomeric polymer-bitumen membrane reinforced with a non-woven polyester fabric, applied over “primed surface with an adhesive bituminous coal (min. 50% solid’s content).
2. Nominal thickness: 4mm ASTM D 751.
3. Softening point of coating mixture: ≥145°C.
4. Penetration of coating mixture: 35 dm ATM D 5
5. Flexibility at low temperature: -10 to 20°C, no cracking
6. Service ambient temperature: -40°C to 80°C
7. Tensile strength: (UE
8. Atc/UNI 8202)
    a. Long. 850 N. /5cm
    b. Transv. 700 N. /5cm
9. Ultimate elongation:(UEAtc/UNI 8202)
    c. Long. = 50%
    d. Transv. = 55%
10. Lap joint strength: (UEAtc)
    e. Long. 850 N. /5cm
    f. Transv. 700 N. /5cm
11. Tear Resistance: ASTM D 5147
    g. Long. = 550N
    h. Transv. = 350N
12. Puncture resistance: UEAtc
    i. Static: L4 (not perforated at 25kg, 10mm ball)
    j. Dynamic: I4 (not perforated at 9 joules impact energy, 5mm ball)
13. Impermeability of the membrane of water: absolutely impermeable, UEAtc
14. Water vapour permeability: absolutely impermeable, ASTM E 96
15. Resistance to aging due to UV-Radiation system: no alteration after 2000hrs (ASTM G53)

16. Resistance to thermal aging: no alteration after the test
17. Type of installation: Torch applied membrane
18. Membrane shall be resistant to chlorides, sulphates and phosphates found in ground water.

2.2 AUXILIARY WATERPROOFING MEMBRANE MATERIALS

A. General: Auxiliary materials recommended by waterproofing system manufacturer for intended use and compatible with waterproofing membrane.

B. Asphalt Primer: ASTM D 41, 350 gr/m2 application. Primer shall be compatible with the applied bituminous membrane.

C. Mastic Sealant: Polyisobutylene, plain or modified bitumen, non-hardening, nonmigrating, nonskinning, and nondrying.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion resistance provisions in FMG 4470, designed for fastening waterproofing membrane components to substrate, tested by manufacturer for required pullout strength, and acceptable to waterproofing system manufacturer.

E. Metal Flashing Sheet: Manufacturer's approved system compatible with protected membrane waterproofing, Aluminum or Stainless Steel; as mentioned in the drawings and approved by the Engineer.

F. Separator Sheet: Polyethylene sheet, 4 mils (0.1 mm) thick, minimum.

G. Miscellaneous Accessories: Provide miscellaneous accessories recommended by waterproofing system manufacturer.

H. Expansion joint support: type recommended by Manufacturer.

I. Protection board for waterproofing system: shall be extruded polypropylene board 5 mm thick, with minimum weight 1000 g/m², Water absorption Nil (ASTM 1004) and minimum puncture resistance of 2000 Newton in accordance with ASTM E 154.

2.3 SIKA TILES

A. Apply sika tile with sealant as per manufacture recommendation and approved of the Engineer.

PART 1 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of waterproofing system:
   1. Verify that waterproof openings and penetrations are in place and set and braced.
   2. Verify that materials that will impair adhesion of waterproofing components to substrate, top and external faces of concrete elements have been removed.

3. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to waterproofing installation according to waterproofing system manufacturer's written instructions. Remove sharp projections.

B. Prime surface of external surfaces of Concrete elements with asphalt primer at a rate recommended by the Manufacturer and allow primer to dry.

3.3 WATERPROOFING MEMBRANE INSTALLATION, GENERAL

A. Install waterproofing membrane system (double layer) according to waterproofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen waterproofing."
B. Install waterproofing system MBS 2 C, according to specification-plate classifications in NRCA's "The NRCA Waterproofing Manual" and requirements in this Section.
C. Start installation of waterproofing membrane in presence of waterproofing system manufacturer's technical personnel.
D. Where top face of concrete elements slope exceeds 1:18, install waterproofing membrane sheets parallel with slope.
E. Cooperate with testing and inspecting agencies engaged or required to perform services for installing waterproofing system.
F. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of waterproofing system.
G. Asphalt Heating: Do not raise waterproofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed waterproofing asphalt manufacturer's recommended temperature limits during waterproofing asphalt heating. Do not heat waterproofing asphalt within14 deg C of flash point. Discard waterproofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.
H. Substrate-Joint Penetrations: Prevent waterproofing asphalt from penetrating substrate joints, entering building, or damaging waterproofing system components or adjacent building construction.

3.4. SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

A. Corners shall be treated using mortar filler (angle fillet) and mesh before membrane application
B. Install modified bituminous waterproofing membrane sheet according to waterproofing manufacturer's written instructions. Extend waterproofing membrane sheets over and terminate beyond cants, installing as follows:
    1. Adhere to substrate in a solid mopping of hot waterproofing asphalt applied at not less than 218 deg C.
    2. Adhere to substrate in cold-applied adhesive.
    3. Torch apply to substrate.
    4. Unroll waterproofing membrane sheets and allow them to relax for minimum time period required by manufacturer.
C. Laps: Accurately align waterproofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids. Laping should be minimum 10 cm on longitudinal sides and 15 cm at the ends.
    1. Repair tears and voids in laps and lapped seams not completely sealed.

3.5. FLASHING AND STRIPPING INSTALLATION

A. Install base flashing over cant strips and other sloping and vertical surfaces, at waterproof edges and secure to substrates according to waterproofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by waterproofing system manufacturer.
2. Backer Sheet Application: Install backer sheet and adhere to substrate in cold-applied adhesive at rate required by waterproofing system manufacturer.
3. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by waterproofing system manufacturer.

B. Mechanically fasten top of base flashing securely at terminations of waterproofing.

C. Seal top termination of base flashing as per waterproofing system manufacturer's written instruction.

1. Install stripping according to waterproofing system manufacturer's written instructions.

3.6. FIELD QUALITY CONTROL

A. Upon completion and before covering with protection materials the waterproofing system shall be subjected to testing according to waterproofing system manufacturer's written instructions.
B. After covering the waterproof, it shall be tested again as above described. The Contractor shall arrange for all material and labor required for the execution of the test. After inspection of works the Contractor shall make good any repairs required to the satisfaction of the Engineer. After repairing a new test will be performed if required by the Engineer.
C. Repair or remove and replace components of waterproofing system where test results or inspections indicate that they do not comply with specified requirements.
D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements
E. A flood testing shall be applied for a period of not less than 72 Hours, if applicable.

3.7. PROTECTING AND CLEANING

A. Protect waterproofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger waterproofing, inspect waterproofing for deterioration and damage, describing its nature and extent in a written report, with copies to Engineer and Owner.
B. Correct deficiencies in or remove waterproofing system that does not comply with requirements, repair substrates, and repair or reinstall waterproofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075216

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes the following:

1. Concealed building insulation.
2. Extruded polystyrene
3. Vapor retarders.

B. Related Sections include the following:

1. Division 07 Section “Thermoplastic Membrane Waterproofing".

1.3 DEFINITIONS

A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product certificate of origin.

C. Samples for Verification: Full-size units for each type of exposed insulation indicated.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

E. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities

having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface-Burning Characteristics: ASTM E 84.
2. Fire-Resistance Ratings: ASTM E 119.
3. Combustion Characteristics: ASTM E 136.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace thermal insulation systems that fail in performance, materials, or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 EXTRUDED-POLYSTYRENE INSULATION

A. Manufacturers: Subject to compliance with requirements and to the approval of the Engineer.

1. Carlisle Coatings & Waterproofing Inc.
2. ACC (Dow).
3. Or approved equal.

B. Extruded-Polystyrene Board Insulation: ASTM C 578, of type IV:

1. Thickness: 50 mm unless otherwise indicated on drawings.

C. Technical properties:

1. Density: min. 40 kg/m3
2. Compressive strength at 10 % deflection: 500 Kpa
3. UL classification according to ASTM E84:Maximum flame-spread and smoke-developed indexes of 5 and 165, respectively

4. Flammability: Class B2, as per DIN 4102
5. Capillarity: None
6. Water absorption by submersion: 0.2% (DIN 53428) or < 1 % (ASTM D 2842)
7. Linear coefficient of thermal expansion and contraction: 70x10-6 degree Celsius $^{-1}$.
8. Heavy duty Board glue: of type as required by the engineer.

2.2 ROCKWOOL

A. Sound and Thermal Insulation Panels: Unfaced mineral-fiber blanket (compressible) insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 612 for Type I.

1. Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.
2. Thickness: as shown on Drawings.
3. Density: 80Kg/m³ minimum, ASTM C303.
4. Shot content: <20% by weight, ASTM C612.
5. Water vapor absorption: <1% by weight, ASTM C1104.
6. Thermal conductivity: 0.034W/mºC, ASTM C177.
7. Max use Temperature: 750ºC, ASTM C411.
8. Fungi resistance: Does not promote growth, ASTM C665
9. Noise reduction coefficient (NRC): 1, ASTM C423.
10. Sound Transmission class: ASTM E90.
11. Identify materials with appropriate markings of applicable testing and inspecting agency.
    a. Surface-Burning Characteristics: ASTM E 84.
    b. Flame spread: <25, ASTM E84.
    c. Smoke developed: <50, ASTM E84.
    d. Fire-Resistance Ratings: ASTM E 119.
    e. Combustion Characteristics: non combustible, EN ISO 1182 or ASTM E 136
    f. Fire Rating: 90minutes, unless otherwise specified, tested to BS 476.
12. Fire rating period : 2 hours
13. Manufacturer: IROC or approved equal.

2.3 VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

C. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

2.4 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

2.5 INSULATION FASTENERS

A. Type and size indicated or, if not indicated as recommended by insulation manufacturer for type of application and condition of substrate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to rain.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

3.4 INSTALLATION OF INSULATION

A. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

B. Protect top surface of horizontal insulation from damage during concrete work by applying protection course with joints butted.

3.5 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor-retarder-faced units with vapor retarder in location indicated of construction, unless otherwise indicated.

1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.

1. Retain insulation in place by metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

3.6 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

SECTION 074243 - COMPOSITE WALL PANELS

PART 4 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Aluminum composite panels to façade, system including anchorages, shims, furring, fasteners, gaskets and sealants, related flashing adapters, and masking (as required) for a complete watertight installation.

B. Related Sections:

1. Division 05 Section “Metal Fabrication”
2. Division 07 Section "Thermal Insulation".
3. Division 07 Section "Joint Sealants".

C.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: aluminum composite wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Air Infiltration: ASTM E 283.

C. Water Penetration under Static Pressure: ASTM E 331.

D. Wind Loads, Seismic Loads and Deflection Limits: as per structural design report

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of aluminum-faced composite wall panel and accessory.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Show fabrication and installation layouts of aluminum-faced composite wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.

1. Accessories: Include details of the following items, at a scale of not less than 1:10.

a. Flashing and trim.
b. Anchorage systems.

D. Samples for Initial Selection: For each type of aluminum-faced composite wall panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

2. Include manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each sealant exposed to view.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Aluminum-Faced Composite Wall Panels: Minimum 300 x 300 mm. Include fasteners, closures, and other aluminum-faced composite wall panel accessories.

   a. Composite Panels: Include four-way joint.

2. Trim and Closures: 300 mm long. Include fasteners and other exposed accessories.

3. Accessories: 300mm long Samples for each type of accessory.

4. Exposed Gaskets: 300 mm long.

5. Exposed Sealants: For each type and color of joint sealant required. Install joint sealants in 13mm wide joints formed between two 150mm long strips of material matching the appearance of aluminum-faced composite wall panels adjacent to joint sealants.

F. Delegated-Design Submittal: For aluminum-faced composite wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Wall panels and attachments.

2. Wall-mounted items including doors, windows, louvers, and lighting fixtures.

3. Penetrations of wall by pipes and utilities.

H. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.

2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

J. Field quality-control reports.

K. Maintenance Data: For metal wall panels to include in maintenance manuals.

L. Warranties: Samples of special warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Source Limitations: Obtain each type of aluminum faced composite wall panel from single source from single

manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact joint sealants to joint-sealant manufacturers for testing indicated in subparagraphs below:

1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

a. Perform tests under environmental conditions replicating those that will exist during installation.

2. Submit no fewer than nine pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.

3. Schedule enough time for testing and analyzing results to prevent delaying the Work.

4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.

D. Fire-Resistance Ratings: Where indicated, provide aluminum-faced composite wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, aluminum-faced composite wall panels, and other manufactured items so as not to be damaged or deformed. Package aluminum-faced composite wall panels for protection during transportation and handling.

B. Unload, store, and erect aluminum-faced composite wall panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Store aluminum-faced composite wall panels vertically, covered with suitable weather-tight and ventilated covering. Store aluminum-faced composite wall panels to ensure dryness, with positive slope for drainage of water. Do not store aluminum-faced composite wall panels in contact with other materials that might cause staining, denting, or other surface damage. Do not allow storage space to exceed 49 deg C.

D. Retain strippable protective covering on aluminum-faced composite wall panel for period of panel installation.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of aluminum-faced composite wall panels to be performed according to manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements

before aluminum-faced composite wall panel fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate aluminum-faced composite wall panel assemblies with rain drainage work, flashing, trim, and construction of studs, soffits, and other adjoining work to provide a leak-proof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Taking Over Certificate of the whole of the Works.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace aluminum-faced composite wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: Ten years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Surface: Smooth, flat

2. Thickness: 5 mm, unless otherwise specified.

3. Exterior Finish and color: to the selection of the engineer.

4. Exposed Coil-Coated Finishes:

a. Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

5. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness as per manufacturer.

2.2 MISCELLANEOUS MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

B. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of aluminum/stainless steel-faced composite wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

C. Self-Adhering, High-Temperature Sheet: Minimum 0.76 to 1.0 mm thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

2.3 ALUMINIUM-FACED COMPOSITE WALL PANELS

A. General: Provide factory-formed and -assembled, aluminum-faced composite wall panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment system components and accessories required for weather-tight system.

1. Fire-Retardant Core: Noncombustible, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2.4 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete aluminum-faced composite wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of aluminum-faced composite wall panels unless otherwise indicated.

B. Flashing and Trim: Formed from 0.46mm minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet preprinted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, end walls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent aluminum-faced composite wall panels.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

EXECUTION

3.1 INSTALLATION

A. The aluminium composite panels installed in accordance with the manufacturer's instructions and to the Engineer approval.

B. The contactor shall submit to the engineer for his approval, a complete method statement and material submittal for the application of aluminium composite panels, as shown on drawings and details.

3.2 PREPARATION

A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and aluminum-faced composite wall panel manufacturer's written instructions.

3.3 ALUMINIUM-FACED COMPOSITE WALL PANEL INSTALLATION

A. General: Install aluminum-faced composite wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Commence aluminum-faced composite wall panel installation and install minimum of 30 sq. m in presence of factory-authorized representative.

2. Shim or otherwise plumb substrates receiving aluminum-faced composite wall panels.

3. Flash and seal aluminum-faced composite wall panels at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.

4. Install flashing and trim as aluminum-faced composite wall panel work proceeds.

5. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.

6. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners:

1. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by aluminum-faced composite wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of aluminum-faced composite wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.

1. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

E. Attachment System Installation, General: Install attachment system required to support aluminum-faced composite wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.

2. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.

F. Clip Installation: Attach panel clips to supports at each aluminum-faced composite wall panel joint at locations, spacings, and with fasteners recommended by manufacturer. Attach routed-and-returned flanges of wall panels to panel clips with manufacturer's standard fasteners.

1. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants."

G. Track-Support Installation: Provide manufacturer's standard horizontal and vertical tracks that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach panels to wall by interlocking tracks with perimeter extrusions attached to wall panels. Fully engage integral gaskets and leave horizontal and vertical joints with open reveal.

1. Attach routed-and-returned flanges of wall panels to perimeter extrusions with manufacturer's standard fasteners.

2. Attach flush wall panels to perimeter extrusions by engaging panel edges and by attaching with manufacturer's standard structural silicone adhesive.

3. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.

4. Do not apply sealants to joints unless otherwise indicated on Drawings.

H. Subgirt-and-Spline Installation: Provide manufacturer's standard subgirts and splines that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach wall panels by interlocking perimeter extrusions attached to routed-and-returned flanges of wall panels with subgirts and splines. Fully engage integral subgirt-and-spline gaskets and leave horizontal and vertical joints with open reveal.

1. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.

2. Do not apply sealants to joints unless otherwise indicated on Drawings.

b.

I. Rain Screen-Principle Installation: Provide manufacturer's standard pressure-equalized, rain screen-principle system with vertical channel that provides support and complete secondary drainage system, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach wall panels by engaging horizontal support pins into notches in vertical channels and into flanges of wall panels. Leave horizontal and vertical joints with open reveal.

1. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.

2. Do not apply sealants to joints unless otherwise indicated on Drawings.

c.

3.4 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete aluminum-faced composite wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 3 m with no joints allowed within 610 mm of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with mastic sealant (concealed within joints).

d.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align aluminum-faced composite wall panel units within installed tolerance of 6 mm in 6 m, non-accumulative, on level, plumb, and location lines as indicated and within 3mm offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting.

C. Water-Spray Test: After completing the installation of 23m by-2-story minimum area of aluminum-faced composite wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Engineer.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust completed aluminum-faced composite wall panel installation, including accessories.

E. Aluminum-faced composite wall panels will be considered defective if they do not pass tests and inspections.

F. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Prepare test and inspection reports.

3.7 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as aluminum-faced composite wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of aluminum-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.

B. After aluminum-faced composite wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace aluminum-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 43

SECTION 075400 - THERMOPLASTIC MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Contract and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Thermoplastic Polypropylene membrane mechanically fastened on the vertical surfacesand loose laid on the lower horizontal surfaces of the tank and where shown on drawings.

B. Related Sections include the following:

1. Division 03 Section "Cast-In-Place Concrete".

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide waterproofing materials that are compatible with one another under conditions of service and application required, as demonstrated by waterproofing membrane manufacturer based on testing and field experience.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Submit to the engineer a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: For waterproofing system. Include plans, elevations, sections, details, and attachments to other Work.

D. Samples for Verification: For the following products:

1. 300 mm x 300 mm square of sheet roofing, of color specified, including side and end lap seam.

2. 300 mm length of metal termination bars.

3. Six fasteners of each type, length, and finish.

E. Installer Certificates: Signed by waterproofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install waterproofing system.

F. Qualification Data: For Installer and manufacturer.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of waterproofing system.

H. Research/Evaluation Reports: For components of membrane waterproofing system.

I. Maintenance Data: For waterproofing system to include in maintenance manuals.

J. Warranties: Special warranties specified in this Section.

K. Inspection Report: Copy of waterproofing system manufacturer's inspection report of completed waterproofing installation.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by waterproofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

B. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain components for membrane waterproofing system from waterproofing membrane manufacturer.

D. The Thermoplastic Polypropylene membrane must be non toxic and suitable for drinking potable water. The Thermoplastic Polypropylene membrane should meet or exceed the requirements ANSI/NSF Standard 61 for Drinking Water System Components Health Effects.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver waterproofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, shells life, storage temperature and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Store Geomembrane in the original undisturbed plastic wrap in a cool, shaded area and cover with light-colored, breathable tarpaulins. Geomembrane that has been exposed to the elements for approximately 7 days must be prepared with Weathered Membrane Cleaner prior to hot air welding.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.8 WARRANTY

A. Special Warranty: Written warranty by manufacturer, in which manufacturer agrees to repair or replace components of membrane waterproofing system that fail in materials within specified warranty period. Failure includes leakage.

1. Warranty Period: min. 10 years from date of Substantial Completion.

B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering work of this Section, for warranty period of five years from substantial completion such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders:

1. Warranty includes removing and reinstalling materials related to the waterproofing system.

PART 2 - PRODUCTS

2.1 MEMBRANE

A. Manufacturer: Subject to compliance with requirements, products that may be incorporated into the work include the following:

1. Carlisle SynTec Incorporated

2. Versico Incorporated

3. Firestone Building Products

4. Approved equal.

B. Membrane: A reinforced 1.52 mm (.060 inch) thick Thermoplastic Polypropylene membrane conforming to the following physical properties.

Reinforced Thermoplastic Polypropylene membrane

TYPICAL PROPERTIES AND CHARACTERISTICS			
Physical Property	Test Method	Property Of Unaged Sheet	Property After Aging[1] 28 days @ 158 °F
Tolerance on nominal thickness, % .060 inch nominal	ASTM D 751	± 10 0.054 (1.371)	
Thickness over scrim, in. (mm) .060 inch nominal	ASTM D 4637 Optical Method	0.018 (1.457)	
Hydrostatic resistance, lbf (kN) (Mullen burst)	ASTM D 751 Procedure A	350 (2.4) min. 500 (3.4) typical	350 (2.4) min. 500 (3.4) typical

Breaking strength, lbf (kN)	ASTM D 751 Grab Method	250 (1.1) min. 300 (1.3) typical	250 (1.1) min. 300 (1.3) typical
Elongation at break of fabric, %	ASTM D 751	25 typical	25 typical
Tearing strength, lbf (N)	ASTM D 5884 Tongue Tear	55 (245) min. 100 (445) typical	55 (245) min. 100 (445) typical
Low temperature flexibility, °F (°C)	ASTM D 2136 1/8 in. mandrel 4 hour @ temp.	-40 (-40) max. -50 (-46) typical	
Linear Dimensional Change (shrinkage), %	ASTM D 1204		+/- 1.0 max. - 0.5 typical
Ozone resistance, 100 pphm, 168 hours	ASTM D 1149	No cracks	No cracks
TYPICAL PROPERTIES AND CHARACTERISTICS			
Resistance to water (distilled) absorption After 30 days immersion 122 °F (50 °C) Change in mass, %	ASTM D 471 (coating compound)	1.0 max. 0.5 typical	
Field seam strength, lbf/in. (kN/m) Seam tested in peel	ASTM D 1876	40 (7.0) min. 60 (10.5) typical	
Water vaporpermeance, Perms	ASTM E 96	0.10 max. 0.05 typical	
Puncture resistance, lbf (N) .060 in. nominal	FTM 101C Method 2031	250 (1110) min. 350 (1560) typical	250 (1110) min. 350 (1560) typical
Resistance to xenon-arc weathering Xenon-Arc, 10,080 kJ/m2 total radiant exposure, visual condition at 10X	ASTM G 155 0.70 W/m2 80° C B.P.T.	No cracks No loss of breaking or tearing strength	

2.2 OTHER PRODUCTS

A. Stainless Steel Termination Bar: A 50 mm wide and 6 mm thick stainless steel bar pre-punched 150 mm on center to be used in conjunction with stainless steel fasteners as a membrane termination against structural concrete surfaces. Stainless steel termination bar and fasteners and clamping rings shall be Grade 316 complying with ASTM A276.

B. Flashing: 1 mm or 3 mm thick non-reinforced flashing. The 1 mm thick flashing is used to overlay hot air welded seams and the 3 mm thick flashing is used to terminate around inlet/outlet pipes, overflow drains and to form inside/outside corners in tank lining applications.

C. Weathered Membrane Cleaner: Used to prepare Geomembrane that have been exposed to the elements for approximately 7 days to remove surface oxidation and general construction dirt prior to hot air welding of the Geomembrane or prior to primer application.

D. Welding Rod: 5 mm diameter polypropylene rod, available in white, tan and black, used in conjunction with a extrusion welder to seal exposed scrim along cut edges of Geomembrane, intersections between hot air welded seams and all flashing details.

E. Water Cut-Off Mastic: To prevent moisture migration at compression drains and beneath metal termination bars.

F. Sealant: A single-component, moisture-curing, gun-grade, multi-purpose construction sealant used to seal above termination bars

1. .Maximum VOC content: 420g/L.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the manufacturer's published instructions for the installation of the Lining System including proper substrate preparation and jobsite considerations. Remove construction debris, dust, fins and concrete particulate.

1. Position membrane over the acceptable substrate.

2. To avoid possible damage of the Geomembrane on horizontal surfaces, begin the installation on the vertical surfaces, then horizontal ceiling surfaces starting from the top of the wall working toward the bottom. Periodically, remove construction debris, dust, fins and concrete particulate resulting from fastening membrane on the vertical walls.

3. Fasten vertically using Termination Bars every two panels. Fasten horizontally at ceilings every 90 cm.

4. Fasten consecutive Geomembrane sections and overlap adjoining membrane as per manufacturer's recommendations.

5. Weld overlapping membrane with a Hand Held Welder and apply welding rods to conceal exposed scrim.

6. After removal of accumulated debris on the horizontal surface, loose lay the geotextile fabric (if needed) overlapping edges approximately 30 cm. Extend fabric up the vertical sides of the tank approximately 5 cm.

7. Install Geomembrane loose-laid over the protection fabric overlapping adjoining membrane sheets approximately 40 mm or 100 mm to accommodate for a single or a double hot air weld.

8. Fasten horizontally at bottom perimeters using Termination Bar.

9. Overlay hot air welded seams, if necessary, using 1 mm non-reinforced Flashing and seal edges on all sides with welding rods.

10. Inlet/outlet pipes and overflow drains should be terminated in accordance with the manufacturer's applicable details using flashing.

B. Hot Air Welding Procedures

1. Hot air weld the membrane using an Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's specifications. At all splice

intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam.

2. All splice intersections shall be overlaid with non-reinforced membrane flashing

3. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).

4. Repair all seam deficiencies the same day they are discovered.

5. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete. Cut Edge Sealant is not required on vertical splices.

C. Seam Testing

1. A cotter pin puller is recommended to be used to probe all single hot air welded seams. Probing and air testing of all seams must be done once hot air welds have thoroughly cooled.

D. Welding Rod Extrusion

1. Using an extrusion welder, apply welding rods to all cut edges of reinforced membrane where the scrim is exposed and to all splice intersections as well as flashing details.

E. Water Test

1. A water test shall be made by filling the water tanks or surface receiving the membrane with clean water for at least 48 hours.

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Walls.
2. Horizontal assemblies.
3. Construction enclosing compartmentalized areas.
4. Smoke barriers.

B. All the opening in the fire rated floors and walls shall be filled with approved and appropriate passive fire stop products. Openings include, but are not limited to, the following:

1. All cables penetrates passing through fire rated walls and floors such as cable ladders, sleeves and single conduits.
2. All forms of plastic pipes penetrate at different sizes and material types.
3. Steel pipe penetrates of all types and sizes.
4. Insulated plastic and steel pipes. Chilled, hot and cold water.
5. Cable transits for future cable installations.

C. Related Sections include the following:

1. Division 22 and 23 Sections specifying duct and piping penetrations.
2. Division 26 and 28 Sections specifying cable and conduit penetrations.

1.3 PERFORMANCE REQUIREMENTS

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated. Penetration firestop systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Fire-resistance-rated walls, including partitions, with fire-protection-rated openings.
2. Fire-resistance-rated floor assemblies.

B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814 or BS 476 and EN 1366-3, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:

1. Penetrations located outside wall cavities.
2. Penetrations located outside fire-resistive shaft enclosures.
3. Penetrations located in construction containing fire-protection-rated openings.
4. Penetrating items larger than 100mm diameter nominal pipe or 100 sq. cm in overall cross-sectional area.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 100 mm in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

E. Exposed Penetration Firestop systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84 (UL 723).

F. Provide through-penetration firestop systems complying with speccified US standards or any approved equivalent European standards such as Euronorm or ISO.

G. Provide products that upon curing, do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.

H. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.

I. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.

J. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.

K. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with re-enterable products specifically designed for retrofit.

L. Penetrants passing through fire-resistance rated floor-ceiling assemblies contained within chase wall assemblies shall be protected with products tested by being fully exposed to the fire outside of the chase wall. Systems within the UL Fire Resistance Directory that meet this criterion are identified with the words “Chase Wall Optional”.

M. Provide fire-resistive joint sealants sufficiently flexible to accommodate movement such as thermal expansion and other normal building movement without damage to the seal.

N. Provide fire-resistive joint sealants designed to accommodate a specific range of movement and tested for this purpose in accordance with a cyclic movement test criteria as outlined in Standards, ASTM E-1399, ASTM E-1966 or ANSI/ UL 2079.

O. Provide penetration firestop systems, fire-resistive joint systems, or perimeter fire barrier systems subjected to an air leakage test conducted in accordance with Standard, ANSI/ UL1479 for penetrations and ANSI/UL2079 for joint systems with published L-Ratings for ambient and elevated temperatures as evidence of the ability of firestop system to restrict the movement of smoke.

P. Provide T-Rating Collar Devices tested in accordance with ASTM E-814 or ANSI/UL1479 for metallic pipe penetrations requiring T-Ratings per the applicable building code.

1.4 SUBMITTALS

A. Product Data: For each type of through-penetration firestop system product indicated.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Product Schedule: For each penetration firestop system. Include location and design designation of qualified testing and inspecting agency.

D. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.

F. Installer Certificates: From Installer indicating penetration firestop system has been installed in compliance with requirements and manufacturer's written recommendations.

G. Installer Experience: Installer must provide documentation that he/she has been licensed and/or certified for the installation of firestopping products and materials by the specific

manufacturer which he/she intends to use for this project. Licensing and Certifications are valid for a period of time not to exceed two years. If certification occurred more than two years prior to the commencement of said project, installer status will be suspended until recertification can occur. Installer must furnish a list of five (minimum) projects of a similar nature which have been successfully carried out by said installer. This list shall also contain the following:

1. Project names and addresses
2. Engineer name and addresses
3. Employers name and address
4. Any other information specified

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency indicating through-penetration firestop system complies with requirements.

I. Product Certificates: For through-penetration firestop system products certifying that products furnished comply with requirements, signed by product manufacturer.

J. Field-Constructed Mockup: Prior to installing firestop systems, erect mockups for each different through-penetration firestop system indicated to verify selections made and to demonstrate qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final installations.

1. Locate mockups on site in locations indicated or, if not indicated, as directed by Engineer.
2. Notify Engineer 1 week in advance of the dates and times when mockups will be erected.
3. Obtain Engineer's acceptance of mockups before start of final unit of Work.
4. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging completed unit of Work.
5. Accepted mockups in an undisturbed condition at time of Substantial Completion may become part of completed unit of Work

K. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:

1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

L. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements. The installer should have completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
    a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
    b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
        1) UL in "Fire Resistance Directory."

E. Provide firestopping products containing no detectable asbestos as determined by the method specified in 40 CFR Part 763, Subpart F, Appendix A, Section 1, "Polarized Light Microscopy."

F. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver penetration firestopping system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

C. Notify Employer's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by owner’s inspecting agency and building inspector, if required by authorities having jurisdiction.

1.9 WARRANTY

A. Special Manufacturer's Warranty: Written warranty, signed by penetration firestop systems manufacturer agreeing to furnish and to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works.

B. Special Installer's Warranty: Written warranty, signed by the Installer agreeing to repair or replace penetration firestop systems that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but not limited to:

1. STI – Specified Technologies Inc.
2. Hilti
3. Tremco
4. 3m Fire Protection Products
5. Or approved equal

2.2 PENETRATION FIRESTOPPING

A. Only firestop products which have been third party tested in accordance with UL1479 - ASTM E-814, based on testing at a positive pressure differential of 2.49 Pa, for specific fire rated construction penetrations shall be considered and used. Items shall be tested to specific parameters including the type and number of penetrating items, the size of the penetrating

items, the maximum allowable annular space, and rated for the hourly requirement of the structure.

B. Openings in fire resistant walls shall be provided with appropriate fire stop compounds that maintain a minimum fire resistance rating of 180 min., but less than the fire-resistance rating of constructions penetrated, and prevent the passage of smoke. Non metallic pipes exceeding, 40mm in diameter shall be provided with fire stop jackets on both sides of the fire resistant wall ducts protection shall be as specified in mechanical specification.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Openings in floor slabs shall be provided with appropriate fire stop compounds that maintain a minimum fire resistance rating of 120 min. Non metallic pipes exceeding 40 mm in diameter shall be provided with fire stop jackets on floors underside. Ducts protection shall be as specified in mechanical specification.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: Not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall or floor penetrations not in direct contact with combustible materials.

D. Penetrations in Smoke Barriers: Provide penetration firestop system with ratings determined per UL 1479.

1. L-Rating: Not exceeding a total cumulative leakage of 0.024 cu. m/s for any 9.3 sq. m of wall or floor area.

E. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials, to maintain ratings required and to comply with "Performance Requirements" Article. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:
    a. Slag-wool-fiber or rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.
2. Temporary forming materials.
    a. Substrate primers.
    b. Collars.
    c. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and an integral water and smoke resistant neoprene gasket.

B. Latex Sealants: Intumescent single-component latex formulations that after cure do not re-emulsify during exposure to moisture. Use for sealing nominal openings with penetrations of non-combustible items including; cast and steel pipe, copper pipe, conduit, electrical metallic tubing (EMT).

C. Intumescent Sealants: Single-component intumescent sealants containing water resistant intumescent ingredients that expand a minimum of 8 times when heated.

D. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Use Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces
2. Use nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
3. Use polyethylene foam or mineral wool (64kg/m³ minimumdensity) backing material, unless otherwise recommended by Manufacturer.

E. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

F. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet. Use for large size - complex penetrations which accommodate individual or combinations of cable trays, multiple steel or copper pipes, electrical conduits, busways, or electrical/data/telecommunications cables.

G. Intumescent Putties: Nonhardening dielectric, water-resistant, 100% solids, intumescent putties containing no solvents, inorganic fibers, or silicone compounds.

H. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets faced on both sides with polyethylene film.

I. Mortars:

1. Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar. Use for large size - complex penetrations which accommodate individual or combinations of cable trays, multiple steel or copper pipes, electrical conduits, busways, or electrical/data/telecommunications cables.
2. Gypsum based mortar with fiber strands, mixed with water for trowable or flowable application.
   a. Expands by 1.1% by volume on curing.
   b. Density of cured compound: approximately 900kg/m3.
   c. Bonding to concrete: 10kg/cm2.
   d. Compressive strength: 80 kg/m2

J. Pillows/Bags: Reusable intumescent pillow heat sealed in a fire-retardant poly bag with a noncombustible, monolithic core encapsulated on all sides with intumescent coating. Pillows shall not contain any loose fill. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed. Use for large size - complex penetrations which accommodate individual or combinations of cable trays, multiple steel or copper pipes, electrical conduits, busways, or electrical/data/ telecommunications cables.

K. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

L. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts.

M. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves.

N. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements.

O. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual cable penetrations up to 0.27 in. (7 mm) diameter.

P. Fire Rated Cable Pathways: Re-enterable device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill. These device modules shall be engineered such that two or more devices may be ganged together for greater capacity.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains from firestop system materials. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify through-penetration firestop systems with preprinted vinyl, metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 150 mm of firestop system edge so labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes, but is not limited to sealants for the following applications, including those specified by reference to this Section:

1. Interior joints in the vertical surfaces and horizontal surfaces.
   a. Control and expansion joints in cast-in-place concrete.
   b. Joints between architectural precast concrete units.
   c. Control and expansion joints in unit masonry.
   d. Joints in dimension stone cladding.
   e. Joints in exterior insulation and finish systems.
   f. Joints between different materials listed above.
   g. Perimeter joints between materials listed above and frames of doors and windows.
   h. Control and expansion joints in ceiling and overhead surfaces.
   i. Other joints as indicated.
   j. Control, expansion, and isolation joints in cast-in-place concrete slabs.
   k. Joints between architectural precast concrete paving units.
   l. Joints in stone paving units, including steps.
   m. Tile control and expansion joints.
   n. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   o. Joints between different materials listed above.
   p. Other joints as indicated.
2. Refer to schedule at end of section for sealant type and location.
3. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:
   a. Control and expansion joints in cast-in-place concrete.
   b. Joints between architectural precast concrete units.
   c. Control and expansion joints in unit masonry.
   d. Joints in dimension stone cladding.
   e. Joints in exterior insulation and finish systems.
   f. Joints between different materials listed above.

g. Perimeter joints between materials listed above and frames of doors and windows.
h. Control and expansion joints in ceiling and overhead surfaces.
i. Other joints as indicated.

4. Exterior joints in the following horizontal traffic surfaces:
a. Control, expansion, and isolation joints in cast-in-place concrete slabs.
b. Joints between architectural precast concrete paving units.
c. Joints in stone paving units, including steps.
d. Tile control and expansion joints.
e. Joints between different materials listed above.
f. Other joints as indicated.

B. Related Sections include the following:
1. Division 4 Section "Unit Masonry".
2. Division 7 Section "Penetration Firestopping".
3. Division 8 Section "Glazing".
4. Division 8 Section "Structural-Sealant-Glazed Curtain Walls".
5. Division 9 "Tiling".
6. Division 9 "Stone Flooring".
7. Division 32 "Unit Paving".

1.3 DEFINITIONS

A. Trafficable Sealant: To qualify for traffic use under ASTM C 920 requirements, elastomeric sealants must demonstrate a shore A hardness of not less than 25 nor more than 50.

B. Low Modulus: Tensile strength of 310 kPa or less.

C. Medium Modulus: Tensile strength of not less than 310 kPa or more than 517 kPa. Movement capabilities of ±50 percent.

D. High Modulus: Tensile strength of more than 517 kPa. Joint movement is limited to ±25 percent or less.

1.4 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Sealant shall be capable of withstanding dynamic movement of ± 50 percent.

C. Bond width of the sealant shall be minimum 10 mm.

D. Where required, use acoustical foam tape in conjunction with sealant.

E. Sealant shall be non-chalking, non-cracking, resistant to ultraviolet rays. Based on performance, the sealant shall be non-fire hazard.

F. Fire-Resistive Joint Sealants: Provide joint sealants with fire-resistance ratings indicated, as determined, per ASTM E 119, but not less than that equaling or exceeding the fire-resistance rating of the construction in which the joint occurs.

G. Provide joint sealants for interior applications that have been produced and installed to establish and maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

1.5 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Samples for Verification: For each type and color of joint sealant required. Install joint sealants in 13 mm wide joints formed between two 150 mm long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint sealant depth.
5. Joint-sealant color.

F. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.

G. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.

H. Installer Certificates: Signed by product manufacturer certifying that the Installer is approved, authorized, or licensed by manufacturer to install his products.

I. Installer Experience: List of 5 projects (minimum) of a similar nature carried out successfully by the Installer with the same product endorsed by the manufacturer’s representative.

J. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and Employers, and other information specified.

K. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.

L. Field Test Report Log: For each elastomeric sealant application. Include information specified in "Field Quality Control" Article.

M. Compatibility and Adhesion Test Reports: From sealant manufacturer indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

N. Product Test Reports: From a qualified testing agency indicating sealants comply with requirements, based on comprehensive testing of current product formulations.

O. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use manufacturers standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
    a. Perform tests under environmental conditions replicating those that will exist during installation.
2. Submit not fewer than 9 pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
5. Testing will not be required if joint sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.

2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in peel, and indentation hardness.
4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
5. Include test results performed on joint sealants after they have cured for 1 year.
6. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of nonelastomeric sealant and joint substrate indicated.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
   a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.
      1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

F. Mockups: Before installing joint sealants, apply elastomeric sealants as follows to verify selections made under Sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution:

1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

G. Testing Laboratory Qualifications: To qualify for acceptance, an independent testing laboratory shall demonstrate to the Engineer's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated without delaying progress of the Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.9 SEQUENCE AND SCHEDULING

A. Sequence installation of joint sealants to occur not less than 21 nor more than 30 days after completion of waterproofing, unless otherwise indicated.

1.10 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive the Employer of other rights the Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Provide complete system written warranty signed by the Manufacturer, Installer and Contractor in which they are jointly and severally responsible and agree to repair or replace, without limitations, all or any part of the elastomeric joint sealant assembly that do not comply with performance and other requirements specified in this Section within specified warranty period. Failure includes, but is not limited to: water penetration, adhesive and cohesive failures, deterioration in sealants; other than due to normal ageing and weathering; and any other defects in other components of the work.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Tremco

B. Carlisle

C. Fosroc

D. Or approved equal.

1.2 MATERIALS, GENERAL

E. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing elastomeric sealants that comply with ASTM C 920 and other requirements, including those requirements referencing ASTM C 920 classifications for Type, Grade, Class, and Uses to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by reference to ASTM C

920 for Class 1 or 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

E. Multi-Part Pourable Urethane Sealant for Use T: Type M, Grade P, Class 25; Uses T, M, G, A, and, as applicable to joint substrates indicated, O.

F. Multi-Part Nonsag Urethane Sealant for Use NT: Type M; Grade NS; Class 25; Uses NT, M, A, and, as applicable to joint substrates indicated, O.

G. One-Part Mildew-Resistant Silicone Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates shown, O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to exposure to conditions of high humidity and temperature extremes.

H. Structural Silicone: One part high strength, neutral cure, structural glazing, ASTM C 920, Type S (single component), NS (nonsag), Class 25 (minimum 25% increase and decrease of joint width).

2.3 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: For each product of this description indicated in the Acoustical Joint-Sealant Schedule at the end of Part 3, provide manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:

1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2.4 PREFORMED JOINT SEALANTS

A. Preformed Silicone-Sealant System: For each product of this description indicated in the Preformed Joint-Sealant Schedule at the end of Part 3, provide manufacturer's standard system consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.

2.5 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

1. Type C: Closed-cell material with a surface skin.
2. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.

3. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 40 kg/cu. m and tensile strength of 241 kPa in accordance with ASTM D 1623, and with water absorption less than 0.02 g/cc in accordance with ASTM C 1083.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

D. Elastomeric Tubing Joint Fillers: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to minus 32 deg. C (minus 90 deg. F). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

D. Fire Barrier: Insert prefabricated fire barrier assemblies that have been tested in accordance with ASTM E 119 (BS 476:Pts: 20 and 22), UL 263 procedures for the rating of 2 hours unless indicated otherwise. Material is to carry the label of an independent testing laboratory. Fire barrier assemblies are to include fire barrier and encapsulated insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant

manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water and surface dirt.

2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
   a. Concrete.
   b. Masonry.
   c. Unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.

F. Install sealants by proven techniques to comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
4. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.
    a. Use masking tape to protect adjacent surfaces of recessed tooled joints.

H. Installation of Preformed Tapes: Install according to manufacturer's written instructions.

I. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:

1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
2. Apply a bead of silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's printed schedule and covering a bonded area of not less than a 10 mm. Hold edge of sealant bead inside of masking tape by 6 mm.
3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
4. Complete installation of horizontal joints before installing vertical joints. Lap vertical joints over horizontal joints. At end of joints, cut silicone extrusion with a razor knife.

J. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.

K. Installation of Fire-Resistive Sealants: Comply with the "Performance Requirements" article in Part 1, with ASTM C 1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed elastomeric sealant joints as follows:
    a. Perform 10 tests for the first 300 m of joint length for each type of elastomeric sealant and joint substrate.
    b. Perform 1 test for each 300 m of joint length thereafter or 1 test per each floor per elevation.
2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.
4. Inspect tested joints and report on the following:
    a. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field- adhesion test criteria.
    b. Whether sealants filled joint cavities and are free from voids.
    c. Whether sealant dimensions and configurations comply with specified requirements.
5. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
6. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.

B. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 SEALANT INSTALLATION SCHEDULE

A. General: Unless otherwise indicated, install sealants at the following locations. For locations and applications not specified, install sealants of types recommended by the joint sealant manufacturer.

B. Exterior Joints:
1. Non-Traffic Joints: Multi-part nonsag urethane sealant.

2. Joints Subject to Traffic: Multi-part pourable or nonsag urethane sealant.

C. Interior Joints:

1. Joints Subject to Traffic: Multi-part pourable or nonsag urethane sealant.

2. Non-Traffic Joints:

a. Joints Subject to Movement of 10 to 25 Percent: Multi-part nonsag urethane sealant.

b. Joints Subject to Movement Under 10 Percent: Acrylic sealant.

3. Tiled Areas and Areas Subject to Attack by Mildew: One-part mildew-resistant silicone sealant.

4. Joints in Fire-Rated Construction: Fire-resistive joint sealant.

3.6 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.7 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.8 ELASTOMERIC JOINT-SEALANT SCHEDULE

A. ASTM C 920 classifications related to exposure are designated as follows:

1. Use T classifies sealants designed for joints in surfaces subject to pedestrian and vehicular traffic.

2. Use NT classifies sealants designed for nontraffic areas.

B. Use classifications related to joint substrates are designated as follows:

1. Uses M, G and A refer to sealants that remain adhered to Portland cement mortar (M), clear float glass (G), and clear-anodized aluminum (A).

2. Use O refers to substrate materials other than M, G, and A. Unless it is definitely known that the joint substrate materials for the Project are identical to the materials designated by M, G, and A, retain Use O.

C. Medium-Modulus Neutral-Curing Silicone Sealant: Where joint sealants of this type are indicated, provide products complying with the following:

1. Products: Correlate with para retained in Part 2 article.

2. Type and Grade: S (single component) and NS (nonsag).

3. Colors: White, off white, gray, bronze and black or as selected by Engineer from manufacturer's full line.
4. Class: 25.
5. Additional Movement Capability: 50 percent movement in extension and 50 percent in compression for a total of 100 percent movement.
6. Hardness (shore A): 35-40.
7. Use Related to Exposure: NT (nontraffic), and T (traffic) where approved by the Engineer.
8. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
    a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel, brick, granite, limestone, marble, ceramic tile, and wood.
9. Stain-Test-Response Characteristics: Nonstaining to porous substrates, per ASTM C 1248. Use with porous substrates
10. Applications: General weathersealing, caulking, and also in expansion joints where approved by the Engineer.

D. High-Modulus Neutral-Curing Silicone Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
    1. Products: Correlate with para retained in Part 2..
    2. Type and Grade: M (multi component) and NS (nonsag).
    3. Class: 25.
    4. Use Related to Exposure: NT (nontraffic).
    5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
        a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel, and ceramic tile.
    6. Applications: Structural-sealant-glazed curtain wall system.

E. Multicomponent Nonsag/Pourable Urethane Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
    1. Type and Grade: M (multicomponent) and NS (nonsag) or P (pourable) as directed by the Engineer.
    2. Colors: as selected by the Engineer.
    3. Class: 25.
    4. Additional Movement Capability: 50 percent movement in extension and 50 percent in compression for a total of 100 percent movement.
    5. Use Related to Exposure: T (traffic), and NT (nontraffic).
    6. Uses Related to Joint Substrates: M, [G,] A, and, as applicable to joint substrates indicated, O.
        a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel, granite, limestone, marble, ceramic tile, and wood.

7. Applications: movement joints in walls and floors.

3.9 ACOUSTICAL JOINT-SEALANT SCHEDULE

A. Acoustical Sealant for Exposed and Concealed Joints: Where joint sealants of this type are indicated, provide products complying with the following:

1. Products: Acoustical Sealant for Exposed and Concealed Joints manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following
2. Applications: for joints and applications where acoustic sealant is required.

3.10 PREFORMED JOINT-SEALANT SCHEDULE

A. Preformed Silicone-Sealant System: Where joint sealants of this type are indicated, provide products complying with the following:

1. Products: Manufacturer's standard system consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates .

3.11 INTERIOR JOINTS:

A. Fire-Resistant Wall Penetrations: Refer to Division 7 Section "PENETRATION FIRESTOPPING" for fire-resistant penetration-sealant systems.

B. Vertical Surfaces:

1. Multi-Part Nonsag Urethane Sealant:
   a. Stone Tile on Wall: Perimeter joints between panels.
2. One-Part Nonacid-Curing Silicone Sealant, Medium-Modulus:
   a. Exposed Surfaces of Exterior Walls: Control joints.
   b. Perimeter Joints in Interior Face of Exterior Walls: Perimeter joints in exterior wall.
   c. Formed Metal Framing: Perimeter joints between panels.
   d. Laminated Glass - All Glass Storefronts: Butt glazing.
   e. Laminated Glass - Structural Glass Storefront: Butt glazing.
   f. Interior Stone Veneered Facing: Perimeter joints between panels.
3. One-Part Acid-Curing Silicone Sealant:
   a. Tempered Glass - All Glass Storefronts: Butt glazing.
4. One-Part Mildew-Resistant Silicone Sealant:
   a. Tile: Control joints in areas and other building spaces of hygienic applications.
   b. Toilet Fixtures: Perimeter joints.
5. Latex Joint Sealants (Acrylic-Emulsion Sealant or Silicone Emulsion Sealant):
   a. Hollow Metal Frames: Perimeter joints.

b. Aluminum Metal Frames: Perimeter joints not part of exterior wall.

c. Gypsum Board: Control joints.

d. Field-Painted Surfaces: Vertical and overhead joints.

e. Joints between different materials listed above.

f. Joints not covered by other sealant types.

6. Acoustical Sealant:

a. Non-Fire Rated Partitions: Joints between tops of partitions and underside of structure above.

b. Metal Panel Ceilings: Back of molding.

c. Where indicated on Drawings

C. Horizontal Nontraffic Surfaces:

1. Multi-Part Nonsag Urethane Sealant:

a. Stone: Perimeter joints between panels.

b. Tile: Control joints between tile.

SECTION 079500 - EXPANSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Architectural joint systems for building interiors.
2. Architectural joint systems for building exteriors.
3. Architectural joint systems for open-air structures.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete".
2. Division 04 Section "Unit Masonry".
3. Division 07 Section "Fire-Resistive Joint Systems".
4. Division 07 Section "Joint Sealants".

1.3 DEFINITIONS

A. Maximum Joint Width: Widest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.

B. Minimum Joint Width: Narrowest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.

C. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (mm or inches) or a percentage (plus or minus) of nominal value of joint width.

D. Nominal Joint Width: The width of the linear opening specified in practice and in which the joint system is installed.

1.4 SUBMITTALS

A. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

B. Shop Drawings: Provide the following for each joint system specified:

1. Placement Drawings: Include line diagrams showing plans, elevations, sections, details, splices, blockout requirement, entire route of each joint system, and

attachments to other work. Where joint systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

2. Architectural Joint System Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

a. Manufacturer and model number for each joint system.

b. Joint system location cross-referenced to Drawings.

c. Nominal joint width.

d. Movement capability.

e. Classification as thermal or seismic.

f. Materials, colors, and finishes.

g. Product options.

h. Fire-resistance ratings.

C. Samples for Initial Selection: For each type of joint system indicated.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

D. Samples for Verification: For each type of architectural joint system indicated.

1. Full width by 150 mm long, for each system required.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for current products.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer with not less than 3 years of successful experience in the installation of systems of similar to those required by this project.

B. Source Limitations: Obtain architectural joint systems through one source from a single manufacturer with a minimum 5 years of experience in the design, engineering and fabrication of expansion joint systems.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of architectural joint systems and are based on the specific systems indicated.

1. Do not modify intended aesthetic effects, as judged solely by the Engineer, except with the Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to the Engineer for review.

D. Fire-Test-Response Characteristics: Where indicated, provide architectural joint system and fire-barrier assemblies identical to those of assemblies tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies shall be subjected to hose stream testing.

E. Fire-Resistance Rating: Provide joint system assembly with a rating not less than the rating of adjacent construction.

1.6 COORDINATION

A. Coordinate installation of exterior wall and soffit joint systems with roof expansion assemblies to ensure that wall transitions are watertight. Roof expansion assemblies are specified in Division 07.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace Expansion joint systems that fail in performance, materials, or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works.

2. The warranty shall cover the complete system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. MM system

B. Fosroc

C. Balco, Inc.

D. Or approved equal.

2.2 MATERIALS

A. Aluminum: ASTM B 221M, Alloy 6063-T5 for extrusions; ASTM B 209M, Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

2. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

B. Stainless Steel: ASTM A666, type 316.

C. PVC Vinyl: Extruded wall and ceiling joint cover.

D. Elastomeric Seals: Preformed elastomeric membranes or extrusions to be installed in metal frames.

E. Compression Seals: ASTM E 1612; preformed rectangular elastomeric extrusions having internal baffle system and designed to function under compression.

F. Strip Seals: ASTM E 1783; preformed elastomeric membrane or tubular extrusions having an internal baffle system and secured in or over a joint by a metal locking rail.

G. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.

H. Expansion- and Isolation-Joint-Fillers to Vertical Elements (Walls, Columns): ASTM C 578, Extruded polystyrene, having the following technical properties:

1. Minimum density should be 32-35 kg/m3,
2. Minimum compressive strength = 300 KPa
3. Water Absorption: 1 % by Volume.
4. Thermal Conductivity: 0.032 W/mK
5. Widths and thicknesses: as shown on drawings and details
6. Approved Manufacturer: Carlisle or approved equal.
7. Note: Joints shall agree with the structural requirements.

I. Expansion- and Isolation-Joint-Fillers to Horizontal Elements (Slabs) ASTM C 578, Expanded polystyrene, having the following technical properties:

1. Minimum density should be 22-24 kg/m3,
2. Minimum compressive strength = 150-200 KPa
3. Water Absorption: 1.5 % by Volume.
4. Thermal Conductivity: 0.030 W/mK
5. Widths and thicknesses: as shown on drawings and details
6. Approved Manufacturer: Carlisle or approved equal.
7. Note: Joints shall agree with the structural requirements.

J. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.

K. Backing rod: polyethylene foam backing tube or as per manufacturer requirement and Engineer approved for joints.

L. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required rating period.

1. Insert prefabricated fire barrier assemblies that have been tested in accordance with ASTM E119 (BS 476:Pts: 20 and 22), UL 263 procedures for the rating specified. Fire barrier assemblies are to include fire barrier and encapsulated insulation.
2. Fire barrier material shall be designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43-1, recognized testing and inspecting hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable and approved by the Engineer
3. Insert Materials: Manufacturer’s standard insulation material to provide with the barrier fire-rating specified.

M. Fire Rated Rock Wool Filler:

1. Density: ASTM C303.
2. Thermal conductivity: ASTM C177.

3. Identify materials with appropriate markings of applicable testing and inspecting agency.

b. Surface-Burning Characteristics: ASTM E 84.

c. Fire-Resistance Ratings: ASTM E 119.

d. Combustion Characteristics: non-combustible, EN ISO 1182 or ASTM E 136

e. Tested to BS 476 – Part 20.

N. Moisture Barrier: Manufacturer's standard.

O. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.3 ARCHITECTURAL JOINT SYSTEMS, GENERAL

A. General: Provide architectural joint systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.

1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where joint changes direction or abuts other materials.

2. Include factory-fabricated closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint systems.

B. Design architectural joint systems for the following size and movement characteristics:

1. Nominal Joint Width: As indicated on Drawings.

2. Maximum Joint Width: As indicated on Drawings.

3. Minimum Joint Width: As indicated on Drawings.

4. Movement Capability: Plus or minus 50 percent.

5. Type of Movement: Thermal, Seismic or Wind sway.

2.4 ARCHITECTURAL JOINT SYSTEMS FOR BUILDING INTERIORS

A. Floor-to-Floor and floor-to-wall Joint Systems:

1. Type: Cover plate.

f. Exposed Metal: Aluminum.

1) Finish: Class I, clear anodic.

2. Cover-Plate Design: Recessed to accept field-applied finish materials.

a. Recess Depth: As required to accommodate adjacent flooring.

3. Attachment Method: Mechanical anchors.

4. Load Capacity: Heavy duty.

5. Fire-Resistance Rating: Provide joint system and fire-barrier assembly with a rating not less than the rating of adjacent construction.

6. Moisture Barrier: Manufacturer's standard.

B. Wall-to-Wall, Wall Corner and Wall-to-Ceiling Joint Systems:

1. Type: Vertical cover plate.

a. Exposed Metal: Aluminum.

1) Finish: Class I, clear anodic.

2. Fire-Resistance Rating: Provide joint system and fire-barrier assembly with a rating not less than the rating of adjacent construction.

3. Moisture Barrier: Manufacturer's standard.

C. Ceiling-to-Ceiling Joint Systems:

1. Type: Cover plate.

a. Exposed Metal: Aluminum.

1) Finish: Class I, clear anodic.

2. Fire-Resistance Rating: Provide joint system and fire-barrier assembly with a rating not less than the rating of adjacent construction.

3. Moisture Barrier: Manufacturer's standard.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece and from piece to piece are not acceptable.

⌜ 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and blockouts where architectural joint systems will be installed for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to architectural joint system manufacturer's written instructions.

B. Repair concrete slabs and blockouts using manufacturer's recommended repair grout of compressive strength adequate for anticipated structural loadings.

C. Coordinate and furnish anchorages, setting drawings, and instructions for installing joint systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of joint systems.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing architectural joint assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install joint systems.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify the Engineer where discrepancies occur that will affect proper joint installation and performance.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Locate in continuous contact with adjacent surfaces.
5. Heavy-Duty Systems: Repair or grout blockout as required for continuous frame support and to bring frame to proper level. Shimming is not allowed.
6. Locate anchors at interval recommended by manufacturer, but not less than 75 mm from each end and not more than 600 mm o.c.

C. Seals in Metal Frames: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions according to manufacturer's written instructions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer to both frame interfaces before installing compression seals.

E. Foam Seals: Install with adhesive recommended by manufacturer.

F. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not over pressurize.

G. Terminate exposed ends of joint assemblies with field- or factory-fabricated termination devices.

H. Fire-Resistance-Rated Assemblies: Coordinate installation of architectural joint assembly materials and associated work so complete assemblies comply with assembly performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

I. Water Barrier: Provide water barrier at exterior joints and where called for on Drawings. Provide drainage fittings at a maximum of 15.2 m or where indicated.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over joints. Reinstall cover plates or seals prior to Substantial Completion of the Work.

SECTION 081113 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Flush steel doors.
2. Steel access panels.
3. Steel door frames.
4. Fire-rated door and frame assemblies.
5. Overhead doors.
6. The term "doors" in this section shall also include windows, louvers and frames manufactured in steel.

B. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies".
2. Division 8 Section "Door Hardware".

1.3 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to the Engineer, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure.
2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Fire rated door assemblies that are tested and certified by an accredited fire testing laboratory according to British Standard Specifications (BS 476 parts 20 & 22) are accepted.

C. Fire Resisting Door Components: All components of fire resisting doors and assemblies, including but not limited to: door leaves, frames, ironmongery, hardware and glazing, shall carry identifying labels of an approved independent testing and inspection agency or laboratory, confirming their individual fire resistance rating. The rating of all door components shall be equal to the rating of the door assembly.

D. All hardware used on fire rated doors should comply with same standards of fire rating as doors and in specific of same fire rating hours.

E. Fire Resisting Door Closers: All fire resisting doors shall be fitted with door closers that automatically close and positively latch the door. In case of double-leaf doors, the closing system shall ensure that the inactive door leaf (door leaf with strike) closes first prior to active door leaf (door leaf with lock).

F. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

G. Acoustical assemblies tested to BS EN ISO 140 (Previous BS 2750) and BS EN ISO 717 are accepted.

H. Sound-Rated (Acoustical) Assemblies: Where shown or scheduled, provide door and frame assemblies which have been fabricated as sound-reducing type with acoustical performance as indicated on Drawings.

I. Smoke-Control Door Assemblies: Comply with NFPA 105.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, sound and fire-resistance ratings, and finishes for each type of door and frame specified.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Show fabrication and installation of doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, dimensions of profiles and hardware preparation, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessories.

D. Door Schedule: Submit schedule of doors and frames using same reference numbers for details and openings as those on Drawings.

1. Coordinate glazing frames and stops with glass and glazing requirements.

E. Samples for Initial Selection: Manufacturer's color charts showing the full range of finishes or colors available for units with factory-applied color finishes.

F. Samples for Verification: For each type of exposed finish required, prepared on Samples not less than 75 by 125 mm and of same thickness and material indicated for the Work.

G. Ironmongery: The Contractor shall supply to the manufacturer of doors samples of all item of ironmongery as specified which will be fixed to the frame to ensure that proper provision is made for their fixing, and all details are to be given to the manufacturer as to which items apply to which frames. Ironmongery should be tested and compatible with the fire rating of the door.

H. Construction Samples, approximately 300 by 300 mm, representing the required construction of doors and frames for Project.

1. Doors: Show vertical-edge, top, and bottom construction; insulation; face stiffeners; and hinge and other applied hardware reinforcement. Include louver section and glazing stops if applicable.
2. Frames: Show profile, welded corner joint, welded hinge reinforcement, dust-cover boxes, floor and wall anchors, stops, and silencers. Include panel and louver sections and glazing stops if applicable.

I. Product Certificates: Signed by manufacturers of doors certifying that products furnished comply with or exceed the acceptance criteria of ANSI A250.4 for Level A doors.

J. Fire rating certificate specific to the project should be provided, clearly certifying the doors to be installed in the project.

K. Oversize Fire-rated doors: For units exceeding sizes mentioned on certificate of tested assemblies, provide certification assessment by a testing agency acceptable to authorities that doors conform to all standard construction requirements of tested fire rated doors.

L. Mill test report covering the chemical analysis and physical properties for each type of steel used in the work according to ASTM or BS standard done by qualified independent testing agency.

1.5 QUALITY ASSURANCE

A. Provide steel doors and frames as manufactured by a single firm specializing in the production of this type of product.

B. Manufacturer Qualifications: A firm experienced in manufacturing custom steel doors and frames similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. Supplier should submit evidence of having executed at least three projects of similar nature and complexity, and having an experience of minimum 3 (three) years in such a trade.

C. Each door should have all components (hardwares, accessories and ironmongery) to have fire rated period same as the period of the door itself.

D. Refer to the door schedule for fire rating periods.

E. Refer to the door schedule and for section 087100 “Hardwares” for all ironmongery, hardwares and accessories such as handles, door stops, silencers, kick plates, vision panels, locks, panic bars, Signs, etc…

F. Mockups: Before installing custom steel doors and frames, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location indicated or, if not indicated, as directed by Engineer.
2. Build mockups for each custom steel doors and frames, and anchorage system components.
3. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
4. Obtain Engineer's approval of mockups before fabricating custom steel doors and frames.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Door Manufacturer's Warranty: Provide written Warranty, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that do not fulfill quality and performance requirements or do not comply with tolerances in referenced quality standard such as, but not limited to:

1. Structural failures.
2. Faulty operation of movable parts and hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

B. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palleted, wrapped, or crated to provide protection during transit and Project site storage. Do not use nonvented plastic.

B. Inspect doors and frames, on delivery, for damage. Minor damage may be repaired provided refinished items match new work and are approved by Engineer; otherwise, remove and replace damaged items as directed.

C. Store doors and frames under cover at building site. Place units on minimum 100-mm- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If wrappers on doors become wet, remove cartons immediately. Provide minimum 6-mm spaces between stacked doors to permit air circulation.

PART 2 - PRODUCTS

2.1 Manufacturer

A. Fitzpatrick or approved equal.

2.2 MATERIALS

A. Steel doors shall comply with BS 1245. All mild steel shall comply with BS 4630 and with BS4, Part 1. All sheet steel shall comply with BS 1449, Part 1.

B. Metallic-Coated Steel Sheets for doors and frames: ASTM A 653/A 653M, CS (commercial steel), Type B; with minimum Z275 zinc (galvanized) or ZF275 zinc-iron-alloy (galvannealed) coating.

C. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M of Manufacturer's standard units suitable for the function required.

D. Use of galvanized screws is recommended.

E. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

F. Grout: ASTM C 476, except with a maximum slump of 102mm, as measured according to ASTM C 143/C 143M.

G. Welding shall be in accordance with BS 693 or BS 5135 as appropriate.

H. Sub frames: wherever required by the engineer.

I. All Galvanized steel elements should be Hoy Dip Galvanized, as per ASTM A666 and ASTM A 167.

J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 0.4mm dry film thickness per coat.

K. Intumescent paint at door periphery: Paint certified by a qualified third party for same fire rating period as the door.

2.3 STEEL DOORS

A. General: Provide flush-design doors, minimum 44/60 mm thick, of seamless construction, unless otherwise indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges.

1. Visible joints or seams around louvered panel inserts are permitted.
2. For single-acting swing doors, bevel both vertical edges 3 mm in 50 mm.
3. For double-acting swing doors, round vertical edges with 44 mm radius.

B. Face sheets: Fabricate face sheets of doors from two 1.2 mm or 1.25 mm thick, as indicated on Drawings, metallic-coated, cold-rolled, stretcher-leveled steel sheets and other metal components from hot- or cold-rolled steel sheets, with powder coating finish with epoxy polyester powder coating finish.

C. Thickness of face sheets for fire rated interior doors shall be as recommended by manufacturer to obtain fire rating indicated, but not less than 1.20 mm.

D. Leaf thicknesses: unless otherwise indicated in the door schedule, all metal doors should have total leaf thickness of 44/60 mm.

E. Frame sheet: Provide 1.6mm thick galvanized steel sheets with epoxy polyester powder coating finish.

F. Fire and Non-Fire Door Cores: Provide doors with structurally bonded resin impregnated honey comb to give extra flatness and rigidity having a minimum compressive strength of 1.5kg/cm².

G. Metallic Core Construction, where required: Provide the following core construction welded to both door faces:

1. Steel-Stiffened Core: Galvanized steel vertical stiffeners extending full-door height, spaced not more than 150 mm apart and spot welded to face sheets a maximum of 150 mm o.c.

H. Rock wool Insulation: minimum 96 kg/cu. m density applied to inside surfaces of face sheets of thicknesses and dimensions as shown on drawings, to achieve required fire rating period, unless otherwise specified.

I. Mineral-Fiber Insulation: ASTM C 665, Type I.

J. Wire mesh, fiber glass insect screens

1. Color: Grey
2. Size of opening: as selected by the engineer

K. Top and Bottom Channels: Spot weld metal channel not less than thickness of face sheet to face sheets not more than 150 mm o.c.

1. Reinforce tops and bottoms of doors with inverted horizontal channels of same material as face sheet so flanges of channels are even with bottom and top edges of face sheets.

L. Hardware Reinforcement: Fabricate reinforcing plates from the same material as door to comply with the following:

1. Hinges and Pivots: 5 mm thick by 38 mm wide by 150 mm longer than hinge, secured by not less than 6 spot welds.
2. Lock Face, Flush Bolts, Closers, and Concealed Holders: 3 mm thick.
3. All Other Surface-Mounted Hardware: 1.3 mm thick.
4. Provide inactive leaf of pair door with 3.0mm thick steel flush bolts reinforcements at top and bottom.

M. Dimensions and number of leaves: refer to the door schedule.

N. Tolerances: SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

O. Finishes textures and colors: to the selection of the engineer

P. Wherever required, or stated in the door schedule, doors should have door signs / nbs to the following requirements:

1. Type: Stainless steel of Grade 316, unless otherwise specified
2. Dimensions and thicknesses: as shown on drawings and details.
3. Printing / Symbols / Signs / Finishes: to the selection of the Engineer.

Q. The door shall also include all joints, hinges, accessories, door closers, panic bars, rubber silencers, dust proof sockets, hardwares, fixings, etc…in addition to all elements as shown on drawings and details.

2.4 FRAMES

A. Frames are constructed of 1.6mm (minimum) galvanized steel sheet with epoxy polyester powder coating.

B. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, and continuously welded full depth and width of frame. Knockdown frames are not acceptable.

1. Form frames from metallic-coated cold-rolled steel sheet.

C. Mullions and Transom Bars: Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.

D. Head Reinforcement: Where installed in masonry, leave vertical mullions in frames open at top for grouting.

E. Jamb Anchors: Weld jamb anchors to frames near hinges and directly opposite on strike jamb as required to secure frames to adjacent construction.

1. In-Place Concrete or Masonry: Anchor frame jambs with minimum 9-mm- diameter concealed bolts into expansion shields or inserts 150 mm from top and bottom and 650 mm o.c., but not less than four anchors per jamb. Reinforce frames at anchor locations. Except for fire-rated openings, apply removable stop to cover anchor bolts, unless otherwise indicated.

F. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of same material as frame, 1.5 mm thick, Weld anchors to bottom of jambs and mullions with at least four spotwelds per anchor as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.

2. Cement-Based Screeds: Adjustable type with extension clips, allowing not less than 50-mm height adjustment. Terminate bottom of frames at finish floor surface.

G. Head Anchors: Provide 2 head anchors for frames more than 1066 mm wide and mounted in steel-stud walls.

H. Head Strut Supports: Provide 9-by-50-mm vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.

I. Structural Reinforcing Members: Provide as part of frame assembly, where indicated at mullions, transoms, or other locations to be built into frame.

J. Provide frames with 5.0mm thick steel hinge reinforcements welded to the frames in compliance with BS 7352.

K. Provide frames with 3.0mm thick steel lock strike reinforcement with tapped holes welded to the frames. Standard strike preparation is to be for locks in compliance with doors manufacturer fire test.

L. Head Reinforcement: For frames more than 1200 mm wide in masonry wall openings, provide continuous steel channel or angle stiffener, 2.3 mm thick for full width of opening, welded to back of frame at head.

M. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.

N. Rubber Door Silencers: Except on weather-stripped doors, drill stop in strike jamb to receive three silencers on single-door frames and drill head jamb stop to receive two silencers on double-door frames. Install plastic plugs to keep holes clear during construction. Silencers shall be neoprene, UL-rated for fire doors.

O. Plaster Guards: Provide 0.4-mm- thick plaster guards or dust-cover boxes of same material as frame, welded to frame at back of hardware cutouts to close off interior of openings and prevent mortar or other materials from obstructing hardware operation.

P. Cap: provide colored galvanized steel cap to match frame color.

Q. External frames shall have continuous grooves along perimeter to house weatherstripping

2.5 OVERHEAD DOORS

A. Provide overhead doors with electronic card readers.

B. Material: powder coated galvanized steel.

C. Type: as selected by the Engineer.

D. Dimensions as shown on drawings.

E. Color: as selected by the Engineer.

F. Including all necessary hardware and fixing accessories.

G. Refer to overhead coiling doors section.

2.6 FABRICATION

A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

B. Fabricate doors and frames rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

1. Fabricate doors to comply with acceptance criteria of ANSI A250.4 for a Level A door.

C. Exterior Doors: Provide weep-hole openings in bottom of exterior doors. Seal joints in top edges of doors against water penetration

D. For doors with metallic core construction, weld cores to both doors face sheets.

E. For doors with nonmetallic core construction, laminate core material to both door face sheets with waterproof adhesive.

F. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

G. Exposed Fasteners: Provide countersunk flat or oval heads for exposed screws and bolts, unless otherwise indicated.

H. Thermal-Rated (Insulating) Assemblies: provide doors and frames fabricated as thermal-insulating assemblies and tested according to ASTM C 236 or ASTM C 976. R-value of not less than 2.166 K x sq. m/W when tested according to ASTM C 1363.

I. Hardware Preparation: Prepare doors and frames to receive mortised and concealed finish hardware, including cutouts, reinforcement, mortising, drilling, and topping, according to final hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series specifications and/or BS standards for door and frame preparation for hardware.

1. Reinforce doors and frames to receive surface-applied hardware.
2. Drilling and tapping for surface-applied hardware may be done at Project site.

J. Grout Guards: Formed from same material as frames, not less than 0.4 mm thick. Weld guards to frame at back of hardware mortises in frames to be grouted.

2.7 STEEL FINISHES

A. Pretreatment: Surface of metal to be pretreated with zinc salt phosphatizing for proper chemical conversion and protection of surface.

B. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

C. Factory-Applied Finish: Immediately after cleaning and pretreating, apply manufacturer's standard polyester powder finish consisting of prime coat and topcoat that complies with ANSI A250.3 acceptance criteria. Comply with paint manufacturer's instructions for applying and baking to achieve a minimum total dry film thickness of 80 microns.

1. Color and Gloss: As selected by Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install doors and frames according to DHI A115.IG and manufacturer's written instructions.

B. Frames: Install steel frames for doors, transoms, sidelights, borrowed lights, and other openings, of size and profile indicated.

1. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
2. Install frames with removable glazing stops located on secure side of opening.

3. Install door silencers in frames before grouting.
4. Remove temporary braces necessary for installation only after frames have been properly set and secured.
5. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
6. Apply bituminous coating to backs of frames that are filled with mortar, grout, and plaster containing antifreezing agents.
7. Set masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.
8. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on Shop Drawings.
9. Placing Frames: Set frames accurately in position; plumb; align, and brace securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
    a. At existing concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.
    b. At fire-rated openings, install frames according to NFPA 80.
    c. Field splice only at approved locations. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
    d. Remove spreader bars from each frame only after frame is properly set and secured.
10. Hollow core of frames shall be fully filled with cement sand grout.
11. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar as specified in Division 4 Section "Unit Masonry Assemblies."
12. Concrete Walls: Solidly fill space between frames and concrete with grout. Install grout in lifts and take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
13. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
14. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
    a. Squareness: Plus or minus 1.6 mm, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1.6 mm, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1.6 mm, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1.6 mm, measured at jambs at floor.

C. Doors: Fit non-fire-rated doors accurately in their respective frames, with the following clearances:
    1. Jambs and Head: 2 mm.
    2. Meeting Edges, Pairs of Doors: 3 mm.

3. Bottom: 9 mm, if no threshold or carpet.
4. Bottom: 3 mm, at threshold or carpet.

D. Fire-Rated Doors: Install with clearances as specified in NFPA 80.

E. Smoke Control Doors: Install according to NFPA 105.

3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items just before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.

B. Factory-Finish Touchup: Immediately after erection, sand to feather-edge minor scratched, chipped, or damaged areas and applies touchup of compatible air-drying paint. Minor finish imperfections may be repaired provided finish matches new work finish and is approved by Engineer; otherwise, remove and replace.

SECTION 081216 - ALUMINUM FRAMES

ʁT 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior aluminum frames for doors.
2. Interior aluminum frames for glazing.

B. Related Sections include the following:

1. Division 07 Section "Joint Sealants" for joint sealants installed with interior aluminum frames and for sealants to the extent not specified in this Section.
2. Division 08 Section "Flush Wood Doors" for wood doors installed in interior aluminum frames.
3. Division 08 Section "Door Hardware" for door hardware.
4. Division 08 Section Glazing and Decorative Glass Glazing for glass in interior aluminum frames.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of interior aluminum frame indicated.

B. Shop Drawings: For interior aluminum frames. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: 900mm long framing member with factory-applied finish for each type of interior aluminum frame indicated.

E. Fabrication Sample: For each vertical-to-horizontal intersection of systems, made from 900mm lengths of full-size components and showing details of assembly.

F. Maintenance Data: For interior aluminum frames to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of interior aluminum frames and are based on the specific system indicated. Refer to Employer's General Requirements "Product Requirements."

B. Fire-Rated Door-Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated.

1. Test Pressure: Test according to NFPA 252 or UL 10C and UBC Standard 7-2. After 5 minutes into the test, neutral pressure level in furnace shall be established at 1000 mm or less above the sill.

2. As scheduled on Drawings.

C. Architectural Mockups: Build architectural mockups on site to verify selection made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Reynaers.

B. Schuco International.

C. Or approved equal.

2.2 COMPONENTS

A. Aluminum Framing, General: ASTM B 221M, Alloy 6063-T5 or alloy and temper required to suit structural and finish requirements, not less than 1.6 mm thick.

B. Door Frames: Reinforced for hinges and strikes.

1. Where fire rated system is specified, fabricate frame members for 90-minute fire-protection rating with interior cold-formed, primed, steel liner.

C. Glazing Frames: For glazing thickness indicated.

D. Ceiling Tracks: Extruded aluminum.

E. Trim: Extruded aluminum, not less than 1.6 mm thick, with removable snap-in casing trim, glazing stops, and door stops without exposed fasteners.

2.3 ACCESSORIES

A. Fasteners: Aluminum, nonmagnetic stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.

B. Sound Seals: Manufacturer's standard continuous mohair, wool pile, or vinyl seals.

C. Smoke Seals: Intumescent strip or fire-rated gaskets.

D. Glazing Gaskets: Manufacturer's standard extruded or molded plastic, to accommodate glazing thickness indicated.

E. Glazing: Comply with requirements in Division 08 Section double Glazing.

F. Hardware: Comply with requirements in Division 08 door hardware.

2.4 FABRICATION

A. Machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required, and fastened within frame with concealed screws.

B. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted or mitered connections.

C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.

D. Fabricate all components to allow secure installation without exposed fasteners.

2.5 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Class I, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and ceilings, with Installer present, for conditions affecting performance of work.

1. Verify that wall thickness does not exceed standard tolerances allowed by throat size indicated.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with frame manufacturer's written installation instructions.

B. Install frames plumb, square and angle indicated on drawings, securely anchored to substrates.

C. Install frame components in the longest possible lengths;

1. Fasten to suspended ceiling grid on maximum 1220-mm centers, using sheet metal screws or other fasteners approved by frame manufacturer.

2. Use concealed installation clips to produce tightly fitted and aligned splices and connections.

3. Secure clips to main structural extrusion components and not to snap-in or trim members.

4. Do not leave screws or other fasteners exposed to view when installation is complete.

3.3 CLEANING

A. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AAMA 609 & 610.

B. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Hollow core doors with formica laminate faces.
2. Solid core doors with lamayka finish.
3. Shop priming flush wood doors.
4. Factory finishing flush wood doors.

B. Related Sections include the following:

1. Division 6 Section "Interior Architectural Woodwork".
2. Division 8 Section "Hollow Metal Doors and Frames".
3. Division 8 Section "Door Hardware".

1.3 PERFORMANCE REQUIREMENTS

A. Weather Stripping: provide weather seals to all external doors.

B. All wood doors to support designed loads and forces

1.4 SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction, trim for openings, and louvers.

1. Include factory-finishing specifications.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Fire rating certificate specific to the project should be provided, clearly certifying the doors to be installed in the project.

D. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of mortises and holes for hardware.

2. Indicate dimensions and locations of cutouts.
3. Indicate requirements for veneer matching.
4. Indicate doors to be factory finished and finish requirements.
5. Indicate fire ratings for fire doors.

E. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:

1. Faces of factory-finished doors with transparent finish. Show the full range of colors available for stained finishes.
2. Faces of factory-finished doors with opaque finish. Show the full range of colors available.
3. Sample shall clearly indicate the door inside construction, ply construction, joints details between different members, core construction and other details enabling the Engineer to fully understand the product
4. Mock up

F. Samples for Verification: As follows:

1. Corner sections of doors approximately 400 by 500 mm with door faces and edgings representing the typical range of color and grain for each species of veneer and solid lumber required. Finish sample with same materials proposed for factory-finished doors.
   a. Provide samples for each species of veneer and solid lumber required.
   b. Finish veneer-faced door samples with same materials proposed for factory-finished doors.
2. Grille blade and frame sections, 150 mm long, for each material and finish specified.
3. Frames for light openings, 150 mm long, for each material, type, and finish required.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

B. Quality Standard: Comply with the following standard:

1. AWI Quality Standard: AWI's "Architectural Woodwork Quality Standards" for grade of door, core, construction, finish, and other requirements.
2. NWWDA Quality Standard: NWWDA I.S.1-A, "Architectural Wood Flush Doors."

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to Engineer, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure.
2. Oversized, Fire-Rated Wood Doors: For door assemblies exceeding sizes of tested assemblies, provide manufacturer's certificate stating that doors comply with all standard construction requirements of tested and labeled fire-door assemblies except for size.

D. List of Abbreviations:

1. AWI: American Wood Institute.
2. NWWDA: National Wood Window and Door Association.
3. DHI: Door Hardware Institute.

E. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

F. Acoustical assemblies tested to BS EN ISO 140-(PreviousBS 2750) and BS EN ISO 717 are accepted.

G. Each door should have all components (hardwares, accessories and ironmongery) to have fire rated period same as the period of the door itself.

H. Refer to the door schedule for fire rating periods.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.

1. Individually package doors in cardboard cartons and wrap bundles of doors in plastic sheeting.

B. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

A. General Warranty: Door manufacturer's warranty specified in this Article shall not deprive the Employer of other rights the Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Door Manufacturer's Warranty: Submit written agreement on door manufacturer's standard form, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 6.35 mm in a 1067-by-2134-mm section or that show telegraphing of core construction in face veneers exceeding 0.25 mm in a 75-mm span, or do not comply with tolerances in referenced quality standard.

1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

2. Warranty shall be in effect during the following period of time after the date of Taking Over Certificate of the whole of the Works

   a. Hollow-Core Interior Doors: 5 years.

   b. Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements and to the approval of the Engineer.

2.2 DOOR CONSTRUCTION, GENERAL

A. Edging: Applied solid hardwood edges of species approved by the Engineer and covering edges of faces plies.

   1. Vertical and Horizontal Edges: Minimum 35 mm wide.

   2. Joints between horizontal and vertical edges are to be glued tongue and groove. Provide additional metal connectors where standard with manufacturers.

B. Frames and Sub frames: Powder coated galvanized steel sheets and sections unless otherwise noted.

C. Color and texture: to be selected by the Engineer.

D. Fire Rating: as shown on drawings and door schedule.

E. Sound-Rated (Acoustical) Assemblies: Where shown or scheduled, provide door and frame assemblies which have been fabricated as sound-reducing type of acoustical performance as indicated on Drawings. Provide acoustical doors with rubber gasket as shown on Drawings.

F. Provide samples to Engineer for approval based on Drawings, schedules and Finish Data Sheets.

2.3 SOLID CORE WOODEN DOORS

A. Core: Solid core wood, of Beech wood type and of minimum thickness of 22 mm, unless otherwise specified.

B. Facing: 12 mm Chip-Board, from each side

C. Veneer: None.

D. Painted doors (refer to division 9 high performance coating)

E. Total door thickness = 50 mm, unless otherwise specified.

F. Fire Rating: Solid core wooden doors should have a fire rating period of 90 minutes (1.5 hour), unless otherwise specified or shown on the door schedule

G. Finishes textures and colors: to the selection of the engineer

H. Dimensions: as shown on drawings and details

I. Frames: All frames to wooden doors should be made of galvanized steel powder coated finish, unless otherwise specified.

J. Wherever required, or stated in the door schedule, doors of type (xxx) should have Aluminum Ventilation grills to the following requirements:

1. Type: Anodized Aluminum, unless otherwise specified.

2. Dimensions and thicknesses: as shown on drawings and details.

K. Wherever required, or stated in the door schedule, doors of type (xxx) should have kick plates to the following requirements:

1. Type: Stainless steel of Grade 316

2. Dimensions and thicknesses: as shown on drawings and details.

L. Wherever required, or stated in the door schedule, doors of type (xxx) should have door signs / nbs to the following requirements:

1. Type: Stainless steel of Grade 316, unless otherwise specified

2. Dimensions and thicknesses: as shown on drawings and details.

3. Printing / Symbols / Signs / Finishes: to the selction of the engineer.

M. The door shall also include all lippings, joints, hinges, accessories, door closers, panic bars, rubber silencers, dust proof sockets, hardwares, fixings, etc…in addition to all elements as shown on drawings and details.

2.4 VENEERED-FACED HOLLOW CORE DOORS

A. Door Leaf Frame: Stiles and rails shall be of dimensions as indicated on Drawings. Door-leaf-frame components shall be continuously lipped at outer edges with 15 mm thick lipping constructed of hardwood walnut, unless otherwise specified. Hardwood lipping shall be fixed to stiles and rails in continuous glued tongue-and-groove joints. Stiles, rails and lipping of door leaf frame shall be constructed in one piece. No jointing or splicing shall be permissible. Joints between stiles and rails shall be glued mortise-and-tenon.

B. Hollow Cores: Shall be tubular chipboard core fabricated from wood chips mixed with synthetic resin.

1. Minimum density: 400 kg/m³.

2. Thickness: 33mm.

C. Facing: Facing material shall be 8mm thick Medium density fiber (MDF) board glued to both sides of core with thermosetting resin adhesive. Facing material shall extend flush and uniform, in both directions, between inner edges of lipping. Extend facing in one piece; no jointing or splicing shall be permissible.

1. Facings shall be machine engraved to the pattern selected by the engineer.

D. Artificial Veneer: Lamayka decorative laminate shall be high pressure laminated in pressing operation using a thermosetting adhesive.

1. Thickness: 0.6mm.

E. After bonding and assembling, the entire door shall be abrasive planed before veneering.

F. Thickness of Doors: Unless otherwise indicated on Drawings, thickness of wood door shall be 50.2 mm.

G. Dimensions: as required by the engineer and as shown on the door schedule.

H. Refer to the door schedule for all necessary dimensions, types, thickness, finishes and the like.

I. The door shall also include all lippings, joints, hinges, accessories, door closers, panic bars, rubber silencers, dust proof sockets, hardwares, fixings, etc…in addition to all elements as shown on drawings and details.

2.5 LOUVERS AND LIGHT FRAMES

A. Aluminium Grilles:

1. Metal and Finish: Extruded aluminum with Class I, powder coated finish, color to be selected by the Engineer.

2.6 FABRICATION

A. Fabricate flush wood doors in sizes indicated for Project site fitting.

B. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:

1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements of NFPA 80 for fire-rated doors.

C. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

D. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Grilles: Factory install grilles in prepared openings.

E. Exterior Doors: Factory treat exterior doors with water repellent after manufacturing has been completed.

2.7 FACTORY FINISHING

A. General: Comply with referenced quality standard's requirements for factory finishing.

B. Finish wood doors at factory.

C. Finish wood doors at factory that are indicated to receive transparent finish. Field finish wood doors indicated to receive opaque finish.

D. Transparent Finish: Comply with requirements indicated for grade, finish system, staining effect, and sheen.

1. Grade: Premium.
2. Finish: AWI System TR-6 catalyzed polyurethane to achieve scratch resistant finish.
3. Staining: Provide samples to Engineer for approval based on Drawings.
4. Effect: Filled finish.
5. Sheen: Provide samples to Engineer for approval based on Drawings.

E. Opaque Finish: Comply with requirements indicated for grade, finish system, color, and sheen.

1. Grade: Premium.
2. Finish: AWI System OP-4 opaque conversion varnish.
3. Color: Provide samples to Engineer for approval based on Drawings.
4. Sheen: Provide samples to Engineer for approval based on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Division 8 Section "Door Hardware."

B. Manufacturer's Written Instructions: Install wood doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.

1. Wherever required, Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.

1. Clearances: Provide 3.2 mm at heads, jambs, and between pairs of doors. Provide 3.2 mm from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 6.4 mm from bottom of door to top of threshold.

2. Bevel non-fire-rated doors 3-1/2 degrees at lock and hinge edges.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation, if fitting or machining is required at Project site.

3.3 ADJUSTING AND PROTECTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Refinish or replace doors damaged during installation.

C. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Substantial Completion.

SECTION 083323 - OVERHEAD COILING DOORS

1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes electric-motor-operated overhead coiling doors (Rolling shutters)

1. Galvanized steel rolling shutter.

B. Refer to Fire and life safety report for fire resistance requirements.

C. Related Sections include the following:

1. Division 5 Section "Metal Fabrications".
2. Division 8 Section "Door Hardware".
3. Division 9 Section " High Performance Coating ".

1.3 DEFINITIONS

A. Operation Cycle: One cycle of a door is complete when it is moved from the closed position to the fully open position and returned to the closed position.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design overhead coiling doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated

B. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated .

1. Wind Loads:
    a. Basic Wind Speed: Wind loading will comply with the Lebanese Regulations. The fundamental value of the basic wind velocity shall be taken $V_{b.0}$: 32 m/s.
    b. Importance Factor: 1.15
    c. Exposure Category: C.
2. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.

C. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to the following: Seismic loads = Zone 2B according to UBC 1997.

D. Operation-Cycle Requirements: Provide overhead coiling door components and operators capable of operating for not less than 20,000 cycles and for 10 cycles per day.

1. Include tamperproof cycle counter.

1.5 SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:

1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.

2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

3. Summary of forces and loads on walls and jambs.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: For special components and installations not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Show locations of replaceable fusible links.

3. Wiring Diagrams: For power, signal, and control wiring

D. Samples for Initial Selection: Manufacturer's color charts showing full range of colors available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection

E. Samples for Verification: Of each type of exposed finish required, prepared on Samples of sizes indicated below.

1. Curtain Slats: 305 mm

2. Bottom Bar: 150 mm with sensor edge.

3. Guides: 150 mm long.

4. Brackets: 150 mm square.

5. Hood: 150 mm square

F. Qualification Data: For Installer.

G. Closeout Submittals

1. Operation and Maintenance Manual.

H. Warranty: submit warranty for complete coiling door system, hardwares and accessories for materials and workmanship for 10 years period, from date of Taking Over Certificate of the whole of the Works

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001:2008 registered and a minimum of ten years experience in producing doors of the type specified.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

C. Source Limitations: Obtain overhead coiling doors through one source from a single manufacturer.

1. Obtain operators and controls from overhead coiling door manufacturer.

1.7 WARRANTY

A. Special Warranty: submit warranty for complete coiling door system, hardwares and accessories for materials and workmanship.

1. Warranty Period: 10 years warranty periodfrom date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/SUBCONTRACTORS

A. Manufacturer/Subcontractors: Subject to compliance with requirements and to the approval of the Engineer.

B. Fathallah and Sons

C. Fitzpatrick

D. Approved equal

2.2 DOOR CURTAIN MATERIALS AND CONSTRUCTION (Coiling Door)

A. Door Curtains: Fabricate electrically operatedoverhead coiling door curtainof interlocking slats, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated but not less than 0.71mm, and as follows:

1. Galvanized Steel Coiling Door and Door Curtain Slats: recommended by steel producer and finisher for type of use and finish indicated.

a. ASTM A 123, for galvanizing steel and iron products.

b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

B. Endlocks: Malleable-iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.

C. Bottom Bar: Consisting of angles, each not less than 3 mm thick; galvanized steel to suit type of curtain slats.

D. Curtain Jamb Guides: Fabricate curtain jamb guides of galvanized steel angles or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Build up units with not less than 5mm thick galvanized steel sections complying with ASTM A 36/A 36M and ASTM A 123/A 123M. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

2.3 DOOR CURTAIN ACCESSORIES

A. General: Form sheet metal hood to act as weatherseal and entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and provide fascia for any portion of between-jamb mounting that projects beyond wall face. Provide hinged covers at side and bottom. Provide intermediate support brackets as required to prevent sagging.

1. Fabricate hoods from stainless steel type 304 steel to ASTM A 666 recommended by steel door producer and finisher for type of use; minimum thickness of 1.5 mm minimum thickness.

2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant. All accessories and fixings shall be fabricated from stainless steel type 304.

B. Push/Pull Handles: For push-up-operated or emergency-operated doors, provide stainless steel lifting handles on each side of door.

1. Provide pull-down straps or pole hooks for doors more than 2130 mm high.

C. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

D. Fabricate locking device assembly with lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bar to engage through slots in tracks.

1. Locking Bars: Single-jamb side operable from inside and outside.

2. Lock cylinder is specified in Division 8 Section "Door Hardware."

3. Keys: Provide Three for each cylinder under GMK

E. Chain Lock Keeper: Suitable for padlock.

F. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

G. Stainless steel plates: dimensions as shown on drawings.

H. Axis: Stainless steel pipe with bearings to allow smooth operation without friction.

I. End plates: stainless steel plates type 304.

J. Tubes, plates, angles, gaskets and the like.

1. Material: stainless steel sections as required by the engineer.

K. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated

1. At door head, use 3-mm thick, replaceable, continuous sheet secured to inside of hood.

2. At door jambs, use replaceable, adjustable, continuous, flexible, 3-mm thick seals of flexible vinyl, rubber, or neoprene

2.4 FINISHES, GENERAL

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 PROTECTION OF COMPONENTS

A. General: Do not deliver to site components that cannot be installed immediately or placed in clean, dry, floored and covered storage.

3.2 INSTALLATION

A. General: Install coiling doors and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports.

B. Submit complete method statement for the execution and installation of all products for the engineer’s approval.

C. The contractor shall coordinate with all related works / trades, wherever required.

3.3 ADJUSTING

A. Lubricate bearings and sliding parts; adjust doors to operate easily, free of warp, twist, or distortion around entire perimeter.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Employer's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

SECTION 085113- ALUMINUM DOORS AND WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes:

1. Fixed and operable aluminum-framed doors, windows and partitions.
2. Aluminium door assemblies
3. Aluminium windows assemblies
4. Pivoting panel assemblies.
5. Sliding and folding Glazed partitions.
6. All other related works and accessories.

B. Related Sections include the following:

1. Division 7 Section “Through-Penetration Firestop Systems”.
2. Division 7 Section "Joint Sealants".
3. Division 08 Section "Glazing".
4. Division 08 Section "Door Hardwares".
5. Division 08 Section "Structural-Sealant Curtain Walls".
6. Division 08 Section “Structural Glass Curtain Walls”.

1.3 DEFINITIONS

A. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide aluminum doors and windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of minimum test size indicated below:

1. Size indicated on Drawings.

B. Structural Performance: Provide aluminum doors and windows capable of withstanding the effects of the following loads, based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:

1. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in meters per second at 10 m above grade. Determine wind loads on resulting design pressures applicable to Project according to the following, based on mean roof heights above grade as indicated on drawings.
    a. Uniform Building Code, 1997 Edition, Exposure D, Basic Wind Speed 160 km/hr.
2. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 19 mm, whichever is less, at design pressure based on testing performed according to AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Deflection Test or structural computations.

C. Thermal Movements: Provide aluminum doors and windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    1. Temperature Change (Range): 35 deg C, ambient; 65 deg C material surfaces.

1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, anodization film properties, EPDM waterproofing system around frame and operating instructions for each type of aluminum door and window indicated.

B. Structural calculation notes for sliding glass panels enclosing the following:
    1. Modulus of Elasticity.
    2. Shear Modulus.
    3. Limiting stress of bending and overall yielding.
    4. Limiting stress for shear.
    5. Limiting stress for local capacity.
    6. Coefficient of linear expansion.
    7. Density.

C. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

D. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details, and the following:
    1. Mullion details, including reinforcement and stiffeners.
    2. Joinery details.
    3. Expansion provisions.
    4. Flashing and drainage details.
    5. Weather-stripping details.
    6. Thermal-break details.

7. Glazing details.
8. Window cleaning provisions.
9. For installed products indicated to comply with design loads, include structural analysis data detailing fabrication and assembly of aluminum doors and windows and used to determine the following:
   a. Structural test pressures and design pressures from wind loads indicated.
   a. Deflection limitations of glass framing systems.

E. Samples for Initial Selection: For units with factory-applied color finishes.
   1. Include similar Samples of hardware and accessories involving color selection.

F. Samples for Verification: For aluminum windows, doors and components required, prepared on Samples of size indicated below.
   1. Main Framing Member: 300mm long, full-size sections of extrusions with factory-applied color finish.
   2. Window and Door Corner Fabrication: 300 by 300mm long, full-size door / window corner including full-size sections of extrusions with factory-applied color finish, weather stripping, and glazing.
   3. Operable Window and Door: Full-size unit with factory-applied finish.
   4. Hardware: Full-size units with factory-applied finishes.
   5. Weather Stripping: 300mm long sections.

G. Product Schedule: For aluminum doors and windows. Use same designations indicated on Drawings.

H. Qualification Data: For Installer,manufacturerand testing agency.

I. Field quality-control test reports.

J. Product Test Reports: Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency for each type, class, grade, and size of aluminum door and window. Test results based on use of downsized test units will not be accepted.

K. Test records showing aluminum alloy properties and profile characteristics (tensile/ yield strength, abrasion, weathering, etc..)

L. Salt spray corrosion resistance test report.

M. Maintenance Data: For operable door and window sash,operating hardware,weather strippingand finishes to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer acceptable to aluminum door and window manufacturer for installation of units required for this Project.
   1. A qualified firm specializing in performing the work of this Section with minimum five years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive

manufacturer's warranty. Include project names and addresses, names and addresses of Engineers and Employers, and other information specified.

2. Engineering Responsibility: Preparation of data for aluminum doors and windows, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum doors and windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

C. Source Limitations: Obtain aluminum doors, windows and hardware through one source from a single manufacturer.

D. Product Options: Information on Drawings and in Specifications establishes requirements for aluminum doors and windows' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by the Engineer, except with the Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to the Engineer for review.

E. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup in building envelope wall in locations approved by the Engineer.
2. Approved mockups may become part of the completed Work if undisturbed at time of substantiation completion.

G. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify aluminum door and window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 WARRANTY

A. Special Warranty: Provide written warranty signed by the manufacturer and the Contractor in which manufacturer agrees to repair or replace aluminum doors and windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
c. Faulty operation of movable sash and hardware.
d. Deterioration of metals, other materials, and metal finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Doors and Windows: Five (5) years from date of Taking Over Certificate of the works.
b. Glazing: As specified in Division 08, Section “Glazing”.

c. Metal Finish: Fifteen (15) years from date of Taking Over Certificate of the works..

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements and to the approval of the Engineer, provide products by the following manufacturer or approved equal:

B. ALUMINIUM PROFILES AND SECTIONS:

1. Reynaers
2. Schuco International.
3. Or approved equal.

C. GLASS AND GLAZING

1. Saint Gobain.
2. Pilkington.
3. GlasTrösch
4. Or approved equal

2.2 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 150-MPa ultimate tensile strength, not less than 110-MPa minimum yield strength, and not less than 2.0-mm thickness at any location for the main frame and sash members.

1. Sheet and Plate: ASTM B 209M.
2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221M.
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 316.

C. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.

1. Reinforcement: Where fasteners screw anchor into aluminum less than 3.2 mm thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.

2. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.

D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

E. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

F. Corner joint: Frame members shall be cut at 45° and corners are reinforced with extruded aluminium crimping cleats and corner braces and securely fixed in place with a two part epoxy adhesive.

G. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when aluminum window is closed.

H. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.

1. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.

I. Replaceable Weather Seals: Comply with AAMA 701/702.

J. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

2.3 DOORS AND WINDOWS

A. Door and Window Type: Fixed, horizontal sliding and side-hinged as indicated on Drawings.

B. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.

C. Thermal Transmittance: Provide aluminum doors and windows with a U-factor maximum indicated at 24-km/h exterior wind velocity and winter condition temperatures when tested according to AAMA 1503.

1. U-Factor: 3.4 W/sq. m x K or less.

D. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.

1. Maximum Rate: 2 cu. m/h x sq. m of area at an inward test pressure of 300 Pa.

E. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.

1. Test Pressure: 15 percent of positive design pressure, but not less than 140 Pa or more than 580 Pa.

F. Forced-Entry Resistance: Comply with Performance Grade 10 requirements when tested according to ASTM F 588.

G. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.

H. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating door and window types indicated.

2.4 SLIDING AND FOLDING GLAZED PARTITIONS

A. Provide sliding, fixed and folding partitions complete with top and bottom aluminium edge profiles unless otherwise noted.

B. Track: Flush or low level track as directed by the Engineer.

C. Glazing system: single clear tempered glass of 12mm minimum thickness.

D. Weather stripping: provide minimum distance between glass panels, weather stripping, flexible wall connection gasket seals, twin PVC brush piles and plastic end caps to the top and bottom profiles to ensure effective weatherproofing.

E. Operating system:

1. Running mechanism: double horizontal stainless steel polyamide coated wheels with maintenance free sealed ball bearings providing continued quiet, quick and easy, smooth operation.

2. An adjustable head section caters for discrepancies, allowing installation in openings that may not be level, up to 16mm.

F. Aluminium finish: supporting rails and track should be polyester powder coated aluminium.

G. Color: As selected by the Engineer.

H. Dimensions: as shown on Drawings.

I. Manufacturer: SOLARLUX or approved equal.

2.5 GLAZING

A. Glass and Glazing Materials: Refer to Division 08 Section "Glazing" for glass units and glazing requirements applicable to glazed aluminum door and window units.

B. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

2.6 HARDWARE

A. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows, and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide nonmagnetic stainless steel.

B. Sill Cap/Track: Extruded-aluminum track with natural anodized finish, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.

C. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from inside only.

D. Four-or Six-Bar Friction Hinges: Comply with AAMA 904.

1. Locking mechanism and handles for manual operation.
2. Friction Shoes: Provide friction shoes or nylon or other non abrasive, non staining, non corrosive, durable material.

E. Horizontal-Sliding Doors and Windows: Provide the following operating hardware:

1. Sash Rollers: Stainless-steel, lubricated ball-bearing rollers with nylon tires.
2. Sash Lock: Spring-loaded, snap-type lock at jambs; two per sash.
3. Limit Device: Sash stop limit device; mounted in bottom of pull stile.
4. Removable Lift-Out Sash: Design doors and windows and provide with hardware to permit removal of sash from inside for cleaning.

F. Side-Hinged Doors and Windows: Provide the following operating hardware:

1. Hinge: Concealed four-or six-bar friction hinge with adjustable-slide friction shoe, two per leaf.
2. Lock: Cam-action, sweep lock handle with strike; one per leaf.
3. Limit Device: Concealed friction adjustor, adjustable stay bar or support arms with adjustable, limited, hold open limit device; located on jamb of each leaf.

G. Vertically pivoted panels: Provide the following operating hardware:

1. Pivot Assembly: Stainless steel pivot assembly designed for center axis pivoting.
2. Limit Device.

2.7 FABRICATION

A. Fabricate aluminum doors and windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Fabricate aluminum doors and windows that are reglazable without dismantling sash.

C. Thermally Improved Construction: Fabricate aluminum doors and windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and door and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

1. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
3. Provide hardware with low conductivity or nonmetallic material for hardware bridging thermal breaks at frame.

D. Weather Stripping: Provide full-perimeter weather stripping for each operable sash.

1. Horizontal-Sliding Doors and Windows: Provide operable sash with a double row of sliding weather stripping in horizontal rails and single- or double-row weather stripping in meeting or jamb stiles, as required to meet specified performance requirements. Provide compression-type weather stripping at perimeter of each movable panel where sliding-type weather stripping is not appropriate.

E. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

F. Mullions: Provide mullions and cover plates as shown, matching door and window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of door and window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of door and window units.

G. Subframes: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 1.6mm thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match door and window units. Provide subframes capable of withstanding design loads of door and window units.

H. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.

I. Glazing Stops: Provide snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Polyester Powder-Coat Finish: Paint finishes to be in accordance with BS EN 12206 and to be Qualicoat Class 2 (min. 60μm). Alternatively paint can be in accordance with AAMA 2604.

1. Aluminium materials shall be pre-treated in full accordance with the powder manufacturer's requirements.
2. Color and Gloss: or as selected by the Engineer from manufacturer’s full range

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate, and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight window installation.

1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Shop Drawings, and manufacturer's written instructions for installing doors and windows, hardware, accessories, and other components.

B. Install doors and windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

D. Install doors and windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency approved by the Engineer to perform tests and inspections and prepare test reports.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed doors and windows shall take place as follows:

1. Testing Methodology: Testing of doors and windows for air infiltration and water resistance shall be performed according to AAMA 502, Test Method A, by applying same test pressures required to determine compliance with AAMA/WDMA 101/I.S.2/NAFS in Part 1 "Performance Requirements" Article.
2. Testing Extent: Three doors or windows as selected by the Engineer. Doors and Windows shall be tested immediately after installation.
3. Test Reports: Shall be prepared according to AAMA 502.

C. Remove and replace noncomplying aluminum door and window and retest as specified above.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes, hardware and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

B. Clean aluminum surfaces immediately after installing doors and windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean factory-glazed glass immediately after installing doors and windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

E. Protect door and window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor door and window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact door and window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. Section Includes

1. Furnish and deliver all finish hardware necessary for all doors, also hardware as specified herein and as indicated and required by actual conditions at the building. The hardware shall include the furnishing of all necessary screws, special screws, bolts, special bolts, expansion shields, drop plates, and all other devices necessary for the proper application of the hardware.
2. Refer to the related door and hardware schedule

B. Related Sections

1. Division 7, Joint Sealants.
2. Division 8, Hollow Metal Doors and Frames.
3. Division 8, Flush Wood Doors.

1.3 REFERENCES

A. European Norms for cycle test and Fire where applicable.

B. Applicable state and local building codes (if any).

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Specification sections.

B. Catalog Cuts: Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

C. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening.

D. Include the following information:

1. Type, style, function, size, material and finish of each hardware item.
2. Name and manufacturer of each item.

3. Fastenings and other pertinent information.
4. Location of each hardware set cross-referenced to indications on Drawings.
5. Explanation of all abbreviations, symbols, and codes contained in schedule.
6. Mounting locations for hardware.
7. Door and frame sizes and materials.
8. Name and phone number for the local manufacturer's representative for each product.

E. Country of origin certificate shall be provided by the Contractor.

F. Mill test report shall be submitted for stainless steel grade 316 hardware.

G. Fire-Rated Door hardware: provide certification by a testing agency acceptable to authorities having jurisdiction that doors hardware comply with standard construction requirements for tested and labeled fire-rated door assemblies. All hardware, including vision panels, shall carry identifying labels of an approved independent testing and inspection agency or laboratory, confirming their individual fire resistance rating. The rating of all door components shall be equal to the rating of the door assembly

H. Master Key Schedule: After a keying meeting between the Engineer, the Contractor and the Hardware Supplier, provide a Masterkey schedule, listing the levels of keying, as well as an explanation of the key system's function, the key symbols used, and the door numbers controlled. This schedule can be submitted as a part of the Hardware Schedule or as a separate schedule.

I. Samples: Submit samples of each type of exposed hardware unit in finish indicated and tagged with full description for coordination with schedule. Samples shall become the property of the Employer.

J. Templates: After final approval of the hardware schedule, provide templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware.

K. Wiring Diagrams: After final approval of the hardware schedule, submit wiring diagrams as required for the proper installation of all electrical, electro-mechanical, and/or electro-magnetic products.

L. Notes:

1. Hardware will not be ordered until a corrected copy of the schedule is returned to the Contractor after being reviewed and approved by the Engineer.
2. The Engineers's approval of the hardware schedule shall not be construed as certifying that the list is complete. Quantities listed in any instance are for Contractor convenience only and are not guaranteed. It is the responsibility of the Contractor to furnish the proper hardware that is required for all openings, whether or not herein listed. Acceptance of the hardware schedule does not relieve the Contractor of responsibility for errors or omissions.

1.5 QUALITY ASSURANCE

A. Substitutions: Products are to be those specified to insure a uniform basis of acceptable materials. Requests for substitutions will require the Engineer's approval and must be made in writing. If proposing a substitute, submit that product data attached to product data for the

specified item and indicate basis for substitution and savings to be made. Provide sample if requested.

B. Supplier Qualifications: A recognized architectural hardware supplier, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project. Having stocking facilities and maintenance service within the country.

C. Single Source Responsibility: Obtain each type of hardware (latch and locksets, hinges, closers, etc.) from a single supplier.

D. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with BS476 part 20-22 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested according to BS to equal compliance with requirements of fire-rated door and door frame labels.

E. Electronic Security Hardware: When electrified hardware is included in the hardware specification, the hardware supplier must employ an individual knowledgeable in electrified components and systems, who is capable of producing wiring diagrams and consulting as needed. Coordinate installation of the electronic security hardware with the Engineer and electrical engineers and provide installation and technical data to the Engineer and other related sub-contractor. Upon completion of electronic security hardware installation, verify that all components are working properly, and state in the required guarantee that this inspection has been performed.

F. Each door should have all components (hardwares, accessories and ironmongery) to have fire rated period same as the period of the door itself.

G. Refer to the door schedule for fire rating periods.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.

B. Each article of hardware shall be individually packaged in manufacturer's original container.

C. The hardware, upon delivery, shall be jointly inventoried by representatives of both the Contractor and the Hardware Supplier. Any irregularities shall be noted at that time and future shortages shall be replaced at the expense of the Contractor.

D. Contractor will provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items so that completion of the Work will not be delayed by hardware losses both before and after installation.

E. Items damaged in shipment shall be replaced promptly and with proper material and paid for by whomever did the damage or caused the damage to occur.

F. All the hardware shall be handled at this project in a manner to avoid damage, marring or scratching. Any irregularities that occur to the hardware after it has been delivered to the project shall be corrected, replaced or repaired by the Contractor at their expense. All hardware items shall be protected against malfunction due to paint, solvent, cleanser or any chemical agent.

G. No direct shipments will be allowed unless approved in writing by the Contractor.

1.7 WARRANTY

A. Starting date for all warranty periods to be date of final handing over of the project.

B. No liability is to be assumed where damage or faulty operation is due to improper usage or abuse.

C. Provide warranty from hardware supplier as follows (all durations to be taken from the date of the Taking over Certificate for the whole of the Works):

1. Closers: Ten years, except electronic closers, three years.
2. Exit Devices: Three years.
3. Hinges: Life of the building.
4. All other Hardware: Three years.

D. Products judged to be defective during the warranty period shall be replaced or repaired in accordance with the manufacturer's warranty, at no cost to the Employer.

1.8 MAINTENANCE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Note that even though an acceptable substitute manufacturer may be listed, the product must provide all the functions and features of the specified product or it will not be approved.

B. Approved Manufacturers: Geze, Imperial, Gianni, EFF EFF, Lawrence, Pemko, Durable, or approved equal.

C. Hardware include but are not limited to Hinges, Floor Hinges & Pivots, Locks (sash locks and dead locks), Cylinders and turns, Exit Devices, Door Closers, Flush Bolts, Lever Handles, Fixed knobs, Escutcheon, Pull handle and push plates, Door Stops & Holders, Dust proof socket, Panic bars and outside trims, Seals & Door Bottoms, Signs, Flush Bolts, Rack Bolts.

D. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.

E. Furnish items of hardware required to complete the work in accordance with these specifications and the manufacturers' instructions. Items of hardware not specified shall be provided even though inadvertently omitted from this specification. Items shall be of equal quality and type.

F. Where the exact types of hardware specified are not adaptable to the finished shape or size of the members requiring hardware, furnish suitable types having as nearly as possible the same operation and quality as the type specified, subject to Engineer's approval.

G. Carefully inspect Project for the extent of the finish hardware required to complete the Work. Where there is a conflict between these specifications and the existing hardware, furnish finish hardware to specification.

2.2 MATERIALS

A. All hardware items to be used in the project shall be Heavy-duty frequent use. Hardware material and finish shall be in stainless steel unless otherwise indicated. Dimensions, colors and finishes shall be selected by the Engineer.

B. Refer to hardware set schedules.

C. HINGES:

1. Double ball bearing butt hinge: 4” x 3” x 3mm, 5 Knuckles, Stainless steel material, with stainless steel pin, removable non rising pin housed in ball bearing.
2. All Hinges to meet EN1935 Class 13.
3. Corrosion resistance grade 4 - 240 hours salt test.
4. Fire rated to BS 476.
5. Finish: satin stainless steel.
6. Product: DURABLE HG-433 or approved equal.

D. SHOWER DOOR HINGE

1. Shower door hinge with automatic closer.
2. Opening angle: 90°.
3. Fixing: Screw fixing to wall.
4. Finish: Brass chrome plated.

E. DOUBLE ACTING SPRING BUTTS HINGE WITH CYLINDRICAL KNOBS

1. Product: AL-ART 101-125 or approved equal.

F. LOCKS:

1. Sashlock to be heavy duty fully enclosed zinc plated lock case, 85mm lockcase, 55 or 70mm backset (as directed by the Engineer), 72 mm centers to suit Euro profile cylinder according EN 1303 and DIN 18252, 8mm follower, stainless steel forend plate and strike plate, stainless steel latch and deadbolt, double throw mechanism deadbolt.
2. Deadlock: same as sashlock without latch.
3. Latch Lock: same as sashlock without deadlatch.
4. Bathroom lock: same as sashlock with normal deadbolt to suit 8mm indicator & turn spindle with emergency release.
5. Locks shall be DIN 18251 class 3 and tested to BS 5872.
6. Fire rated to BS 476.

7. Finish: satin stainless steel.
8. PRODUCTS:
   a. Sash lock: DURABLE S-5572 or approved equal.
   b. Dead lock: DURABLE D-5572 or approved equal.
   c. Bathroom lock: DURABLE B-5572 or approved equal.
   d. Indicator & turn with emergency release: DURABLE I01T01 or approved equal.

G. SLIDING DOOR LOCK.

1. Sliding door lock to be heavy duty, steel epoxy polyester powder coated case, stainless steel forend plate and strike plate. 14mm projection brass deadbolt,
2. Finish: satin stainless steel.
3. Product: IMPERIAL or approved equal.

H. CYLINDERS & KEYING:

Europrofile type cylinder length to suit door thickness + escutcheon. To be single, double or with turn where indicated. To be of non copiable type, protected profiles with anti-pick and anti-drill option from outside. All to be with 6 pin to allow GMK with many sub-masters group, supplied with property card.

1. Conform to en 1303 and DIN 18252, class p2.
2. Finish : Nickel plated or to suit finish of handle as directed by the Engineer.
3. Cylinder's keys shall be of silver nickel.
4. All locks and cylinders shall be keyed per the Engineer's instruction.
5. Provide 3 keys per lock, and a total of 6 masterkeys for each group.
6. All master keys shall be delivered directly to the Engineer by the Hardware Supplier, who shall obtain a receipt for delivery of same.
7. Provide a key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of the number of locks required for the Project.
8. Provide complete cross index system set up by the Hardware Supplier, and place keys on markers and hooks in the cabinet as determined by the final key schedule.
9. Provide hinged-panel type cabinet for wall mounting.
10. Products:
    a. EUROPROFILE SINGLE CYLINDER: DURABLE M-X45 or approved equal.
    b. EUROPROFILE DOUBLE CYLINDER: DURABLE M-F70 or approved equal.
    c. EUROPROFILE CYLINDER & TURN: DURABLE P-F70 or approved equal.

I. CLOSERS:

1. Overhead Surface mounted door closer: All closers to be heavy-duty type with guide rail, adjustable closing force size 2-5, adjustable hydraulic latching action, streamline design and eccentric rack and pinion with Hold Open on non fire doors.
   a. Conform to EN 1154.

b. Door opening angle: 150°

c. Fire rated to BS476

d. Finish : to be Silver.

e. Product: GEZE TS2000G or approved equal.

2. Wherever required: Fully Concealed door closer having adjustable size 2-4 or 3-6 depending on leaf size and width. Conform to EN1154 having the following options:

a. Adjustable closing force.

b. Adjustable closing speed.

c. Adjustable latching force.

d. Adjustable backcheck.

e. Electromagnetic hold open when required.

J. PANIC BARS (AND OUTSIDE TRIM)

1. All Panic device to be of touch pad type suitable for Fire rated and Escape doors. Panic bar to be equipped with outside lever and single cylinder under MK.

2. All double panic doors to be equipped with a vertical panic rod + 1 panic latch. System should not have any restriction on which door to open first.

3. Conform to EN1125, tested for 250000 cycles minimum.

4. Material: stainless steel.

5. Finish: Black (unless otherwise specified).

6. Product: DURABLE – (to suit leaf width) or approved equal.

K. OUTSIDE TRIMS:

1. Installed at the opposite side of the panic device.

2. To be of the same brand of the panic device. Finish to be silver matching the panic device. Equipped with single cylinder under grand master key to activate the lever handle trim.

3. Product: DURABLE E42BK or approved equal.

L. FLUSHBOLT WITH CONCEAL BOLT FIXING:

1. All flushbolts for metal doors to be of heavy duty type suitable for metal doors with rod length 305mm, size 25 x 172mm (unless otherwise specified).

2. All flush bolts for wood doors to be 203 x 19mm size heavy duty surface bolt concealed fixing, lever action type.

3. Material and finish: steel - nickel plated.

4. Products:

a. For wooden doors: DURABLE FB-203W or approved equal.

b. For steel doors: LAWRENCE 401 or approved equal.

M. RACKBOLT:

1. Rackbolt with triangular key.

2. Finish: Satin chrome.
3. Dimensions: as shown on drawings.
4. Product: DURABLE RB-70 or approved equal.

N. SLIDING RAIL

1. Sliding rail with floor guide to suit leaf width and load.
2. 4 high quality precision ball bearings.
3. Rubber bearings for door hangers.
4. 4 damper rings to prevent transmission of roller noise to door panel.
5. Anodized light alloy channel rail and stainless steel bolts and nuts.
6. Internally mounted sealed ball bearings.
7. Vertical and lateral adjustment.
8. Multiple pendulum bearing system automatically compensates for alignment errors.
9. Finish: satin stainless steel.
10. Product: GEZE - PERLAN 120 - or approved equal.

O. DROP SEAL

1. Structural profile with 4 pins in self extinguishing coextruded PVC.
2. Graduated scissor action (seal drops on hinge side before lock side).
3. 14mm drop.
4. Galvanized steel flat springs and actuator in PA reinforced with 20% glassfibre.
5. External profile in 6060 T6 aluminum alloy.
6. Sound insulation of up to 45 db certified by approved party.
7. Tested to 200,000 closing cycles.
8. Fire and smoke rated.
9. Certified for installation in fire rated doors.
10. Product: CCE TOP PLUS or approved equal.

P. SOUND SEAL.

1. Silicon seal fire rated extruded from high temperature silicone effective between -40˚F and 450˚F with high adhesive backing. self extinguishing, non toxic to seal top and sides of door. Seals against smoke, fire, air, sound and weather. Unaffected by sunlight, ozone and ultraviolet rays, will not deteriorate under normal exposure. Meets FAR25.853 installed on jambs and header.
2. Sound seal shall be BHMA and UL classified.
3. Product: PEMKO S88 or approved equal.

Q. DUST PROOF SOCKET:

1. Top of dust proof could be removed for maintenance or cleaning purposes.
2. It should be drilled from the bottom to allow evacuation of water.
3. Material and finish: Satin chrome plated or as selected by the Engineer.

4. Product: DURABLE DPS-01 or approved equal.

R. HANDLES:

1. All handle to be 19mm diam. On sprung ball race bearing rose, solid stainless steel Grade 304, with concealed bolt through fixing screws.
2. Back plates shall be of same material and finish as the handle.
3. Handles to be tested to BS 4951 for durability of mechanism to a minimum of 300,000 cycles.
4. Handles to be tested to BS 476 for fire rated doors.
5. Finish: satin stainless steel.
6. Products:
   a. DURABLE H34B01 or approved equal.
   b. For technical and storage rooms' doors: DURABLE H01B01 or approved equal.

S. FIXED KNOB HANDLES:

1. All handle to be stainless steel with bolt through fixing accessories, length 88 mm, Diameter 52 mm.
2. Finish: Satin stainless steel.
3. Product: DURABLE LK-1 or approved equal.

T. PULL HANDLE

1. In stainless steel Grade 304, to be 19mm diam. 300mm length center, bolt through fixing type.
2. Finish: satin stainless steel.
3. Products: DURABLE PH19X225 or approved equal.

U. PUSH PLATE:

1. 1,5mm stainless steel, grade 304, push plate with smooth edges, round corners, and counter sunk screws holes, 150 x 320mm.
2. Finish: Satin stainless steel.
3. Product: custom made.

V. Europrofile Escutcheon:

1. Europrofile Escutcheon: stainless steel with concealed fixings.
2. Dimensions: as selected by the Engineer.
3. Finish: satin stainless steel.
4. Product: DURABLE ES-02 or approved equal.

W. DOOR STOP:

1. Stainless steel floor mounted door stop of Stainless steel material, oval domed type with rubber, to be fixed at minimum 2/3 of door width from Hinge side.
2. Finish: satin stainless steel.
3. Product: DURABLE T10 or approved equal.

X. SIGNS AND DOOR NUMBERS:

1. Stainless steel material grade 316. Signs for males, females, unisex , disabled and as shown on Drawings.
2. Dimensions: as shown on drawings and details.
3. Product: DURABLE SP-001/SP-002 or approved equal.

Y. DECORATIVE COVER TO SLIDING DOORS

1. Stainless steel material grade 316.
2. Dimensions: as shown on drawings and details.
3. Finish: satin stainless steel.

Z. ELECTRIC STRIKE:

1. Electric strike fail secure with tolerance voltage 12vdc ±15%, break-in resistance 4000N, Height 90mm, width 20mm, finish in stainless steel.
2. Product: EFF EFF - 14FF or approved equal.

AA. CONCEALED SHEARLOCK

1. Electromagnetic lock consisting of electromagnet body and armature Plate.
2. Voltage Tolerance: 10%
3. Current Draw: 420mA@12 VDC; 210mA@24 VDC at temperature 20
4. Magnetic bond sensor monitor output (SPDT rated 3A@30VDC), indicates the door locked or unlocked status.
5. Holding Force: Up to 1200 lbs (545 Kg) in shear.
6. The Gap between the Lock and Armature plate: 2 mm
7. Finishes for magnet and armature plate: Zinc
8. Weight Approx. : 1.2 Kg
9. Product: GEM. GS-200 or approved equal.

BB. CARD READER AND CONTROLLER

1. Access Control ONLINE system.
2. Operating Voltage: 10~14 VDC.
3. Current Draw: average 50mA/12VDC.
4. Transmitting Frequency: 125KHz
5. Output Format: wiegand 26 or 34 bits hexadecimal.
6. Proximity Range: about 10cm, Depending on local installation conditions.
7. Case Material : ABS (UL 94V0)
8. Color : Black
9. Visual Signals: Tri-color LED indicator.
10. Cable: 7 conductors (#22 AWG) standard
11. Product: the ANSI size GemProx-630-EM(Slim type) or approved equal.

CC. POWER SUPPLY

1. Power supply with filtered output and bored up battery suitable for the strike plate and reader, heavy duty.
2. Product: GIANNI or approved equal.

DD. DOOR LOUVERS

1. Fire rated galvanized steel louvers.
2. 1.2mm thick galvanized steel frame and louver blades and 1.5mm thick inner support members.
3. Finish: baked enamel.
4. Tight mitered corners, no visible welds and countersunk mounted holes.
5. UL certified louvers.
6. Tested to BS 476.
7. Including insect screen.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation of any hardware, examine all doors, frames, walls and related items for conditions that would prevent proper installation of finish hardware. Correct all defects prior to proceeding with installation.

3.2 INSTALLATION

A. All hardware will be installed by qualified tradesmen, skilled in the application of commercial grade hardware. For technical assistance if necessary, installers may contact the manufacturer for the item in question, as listed in the hardware schedule.

B. Mount hardware units at heights indicated in “Recommended Locations for Builders Hardware for Standard Steel Doors and Frames” by the Door and Hardware Institute.

C. Install each hardware item in compliance with the manufacturer’s instructions and recommendations, using only the fasteners provided by the manufacturer.

D. Do not install surface mounted items until finishes have been completed on the substrate. Protect all installed hardware during painting.

E. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

F. All operating parts shall move freely and smoothly without binding, sticking, or excessive clearance.

G. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Section 079000 (Joint Sealers).

3.3 ADJUSTING, CLEANING, AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door, to insure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly.

B. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make a final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

C. Clean adjacent surfaces soiled by hardware installation.

D. Instruct Owner's personnel in the proper adjustment, lubrication, and maintenance of door hardware and hardware finishes.

3.4 FIELD QUALITY CONTROL

A. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer, accompanied by representatives of the manufacturers of latchsets and locksets, door control devices, and of other major hardware suppliers, shall return to the Project to perform the following work:

1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.5 PROTECTION

A. Provide for the proper protection of all items of hardware until the Engineer accepts the project as complete. Damaged or disfigured hardware shall be replaced or repaired by the responsible party.

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Doors and Windows.
2. Frameless doors and partition assemblies.
3. Glass to stairs.
4. Glazed Vision panels.
5. Tempered glass panels.
6. Laminated glass with PVB lamination.
7. Tempered Laminated Glass.
8. Glazing to curtain walls.
9. Clear glass, tinted glass, fritted glass, sand blasted glass and others.
10. Straight and curved glass.

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions.

Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm and validate glass thicknesses by test shock and by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
    a. External Glass Design Wind Load: Uniform Building Code (UBC) Edition, Exposure D, Basic Wind Speed 160 km/hr.
    b. Seismic Load: Uniform Building Code (UBC), 1997 Edition, Zone 2B.
    c. Lateral Loads: 240Pa.
    d. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 25 mm, whichever is less.
        1) For monolithic-glass lites heat treated to resist wind loads.
        2) For insulating glass.
        3) For laminated-glass lites.
    e. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 35 deg C, ambient; 65 deg C, material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
2. For laminated-glass lites, properties are based on products of construction indicated.

3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.

E. Heat Treated Glass: Provide heat-treated glass that is free from nickel sulphide. Provide certificate from supplier that all heat-treated glass units have successfully passed heat-soak test.

1. Test the following:
   a. Full testing for glass with “pinned support system” and as specified.
   b. Statistical testing for other glass applications.
   c. Heat soak tests
   d. Impact test
   e. Status of broken pieces test
   f. Shock resistance test
   g. Chemical composition of glass

F. Fire-Resistive Glazing: Provide glazing products which are tested and listed by UL, for the fire resistance ratings required.

1. Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to Engineer, for fire ratings indicated, based on testing according to NFPA 252.
2. Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.

G. Structural Performance: Provide glass cladding system capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Wind Loads: Determine loads based on the following minimum design wind pressures:
   a. Uniform Building Code (UBC), Exposure D, Basic Wind Speed 160 Km/hr.

H. Seismic Performance: Provide glass cladding system capable of withstanding the effects of earthquake motions determined according to Uniform Building Code (UBC), 1997 Edition, Zone 2B.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Samples: For the following products, in the form of 300mm square Samples for glass and of 300mm long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

D. Samples: For the following products, in the form of 300mm square Samples for glass.

1. Each type of patterned glass.

2. Coated vision glass.
3. Fire-resistive glazing products.
4. Each type of laminated glass type.
5. Insulating glass for each designation indicated.
6. For each color of exposed glazing sealant indicated.
7. Back painted glass.
8. Laminated glass with colored interlayer.
9. Sand blasted glass.
10. Tempered clear glass

E. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

F. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

G. Qualification Data: For installers.

H. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

I. Shop Drawings:

1. Plans and sections showing components, layout, configuration, and dimensions.
2. Illustrate method of assembly, installation, and glazing.
3. Provide details for secondary support framing, connections, joints and other fabrication and installation conditions.
4. Indicate required tolerances and coordination with adjacent elements and work of other trades.

J. Product Test Reports: For all types of glass, sealants and accessories, not limited to the following:

1. Heat Treated Glass
2. Low-e coated glass.
3. Insulating glass.
4. Glazing sealants.
5. Glazing gaskets

K. Loading Requirements: Submit calculation sheets showing that the specified glass can withstand the actual loading requirements.

L. In situ testing should be executed by the contractor for randomly selected panels (by the engineer and in his presence), by an independent qualified testing agency.

M. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.

B. Source Limitations for Glass: Obtain each type of glass from a single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

D. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.

1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

E. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.

1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.

F. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

1. Use manufacturer’s standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

G. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

H. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency or manufacturer acceptable to authorities having jurisdiction.

I. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA “Glazing Manual” and "Laminated Glass Design Guide".
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

J. Design structural components and develop shop drawings under direct supervision of professional structural engineer experienced in design of glass structures.

K. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by the Engineer.
2. Build mockups with the same kinds of glass to match glazing systems required for Project, including typical lite size, framing systems, and glazing methods.
3. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
4. Obtain Engineer’s approval of mockups before starting fabrication.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed.
7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

L. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 4.4 deg C.

1.9 WARRANTY

A. Manufacturer's Special Warranty for all Glass Products: Provide written warranty made out to the Employer and signed by glass manufacturer agreeing to replace glass units that deteriorate, within specified warranty period indicated below.

1. Warranty Period for all types of glazing and accessories: 10 years from date of Taking Over Certificate of the whole of the Works
2. Warranty Period for all types of sealants: 20 years from date of Taking Over Certificate of the whole of the Works

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products and Manufacturers: Subject to compliance with requirements and to the approval of the Engineer but are not limited to the following:

1. Saint Gobain.
2. Pilkington.
3. GlasTrösch;
4. or approved equal.

2.2 PRIMARY FLOAT GLASS

A. Float Glass: ASTM C 1036, Type I (transparent glass, flat), Quality Q3, Class I (clear); with a minimum of 91 percent visible light transmission and a minimum solar heat gain coefficient of 0.87.

2.3 MONOLITHIC TEMPERED GLASS

A. General: Fully tempered glass is a glass that has been heat-treated.

B. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.

C. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent glass, flat); Quality Q3, kind FT.

2.4 COATED FLOAT GLASS

A. General: Provide coated glass complying with requirements indicated in this Article.

1. Provide Kind HS (heat-strengthened) coated float glass in place of coated annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in “Performance Requirements” Article.
2. Provide Kind FT (fully tempered) where safety glass is indicated.

B. Low-E High Performance Glass: Clear float glass with coloured metallic-oxides coating deposited in process combining the reaction of high temperature and a gas (Chemical Vapor Deposition) that creates perfectly uniform layers of metal oxides in hard pyrolytic coating. Low-e glass is to combine both solar control and thermal insulation properties as well as neutrality and low reflection architectural properties and shall comply the following requirements:

1. Primary glass: Clear float
2. Type of coating: metallic oxides
3. Surface of coating: #2, unless otherwise specified
4. Thickness: as indicated on Drawings
5. Light Transmittance: 68%, minimum
6. Light reflectance: 9%, in external position
7. U-value (Summer): 2 W/m².C, maximum (EN 673)
8. Shading coefficient: 0.50, maximum (EN 410)
9. Heat treatment: As specified in Sub-Clause 2.4/A

2.5 LAMINATED GLASS

A. Laminated Glass: Comply with ASTM C 1172 for kinds of laminated glass indicated and other requirements specified.

B. Interlayer: Interlayer material as indicated below, clear or in colors, and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass tiles and installation.

1. Interlayer Material: Polyvinyl butyral sheets.
2. Fire polyvinyl butyral interlayers, laminate lites in autoclave with heat pressure.

C. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:

1. Laminate lites with polyvinyl butyral interlayer in autoclave with heat plus pressure.

2.6 INSULATING GLASS

A. Insulating-Glass Units: Preassembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA unit.

1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in “Performance Requirements” Article. Provide Kind FT (fully tempered) where safety glass is indicated.

B. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated in the Drawings are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit’s edge.

C. Sealing System: Dual seal, with primary and secondary sealants as follows:

1. Polyisobutylene and silicone.

   or

2. Polyisobutylene and polyurethane.

D. Spacer Specifications: spacer bar with bent corners and straight welded or keyed joints complying with the following requirements:

1. Stainless steel.
2. Desiccant: Molecular sieve or silica gel, or blend of both.
3. Corner Construction: Manufacturer's standard corner construction.

2.7 FRITTED GLASS

A. Ceramic frit shall be used to print nonfading patterns, shown on drawings, onto glass.

B. Fritted tempered glass.

C. Heat-treated glass with ceramic coating shall comply with ASTM C1048 and shall be acid resistant, alkali-resistant, heat resistant and impact resistant.

D. Ceramic frit Spandrel glass: shall be opaque with a fired on ceramic frit paint for non-vision applications.

E. Ceramic frit silk-screen glass: shall have ceramic frit paint applied with a silk screen pattern of translucency as indicated on Drawings.

F. Color: to the selection of the Engineer.

2.8 ELASTOMERIC GLAZING SEALANTS

A. For sealant specifications refer to Division 07, Section "Joint Sealants".

B. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by the Engineer from manufacturer's full range for this characteristic.

C. Elastomeric Glazing Sealant Standard: Comply with ASTM C 920 and other requirements indicated for each liquid-applied, chemically curing sealant, including those referencing ASTM C 920 classifications for type, grade, class, and uses.

1. Additional Movement Capability: Where additional movement capability is specified in the Glazing Sealant Schedule, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at time of

installation and remain in compliance with other requirements in ASTM C 920 for uses indicated.

D. Glazing Sealant for Fire-Resistance Glazing Products: Identical to product used in test assembly to obtain fire-protection rating.

2.9 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tape: Closed-cell, PVC foam tape; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.10 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

1. EPDM, ASTM C 864.

2.11 NONSHRINK GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C 1107; of consistency suitable for application.

2.12 FRAMELESS PARTITION ASSEMBLIES

A. General: Provide complete frameless partition assemblies including hinged and sliding door panels and hardware for locations indicated on drawings.

B. Glazing:

1. Thickness: as shown on Drawings.

C. Unexposed fixing channels and sections: hot-dip galvanized steel, unless otherwise shown on Drawings,

D. Exposed fixing channels and sections: stainless steel grade 316, unless otherwise shown on Drawings.

E. Door Hardware: Heavy duty type, Equip all-glass door assembly with pivots, hinges, handles and all hardware required for complete, functional, durable installation. Items shall be selected as appropriate for application, door size, weight, and attachment method to the approval of the Engineer.

F. Rubber Band: around fixing locations of color to match the finishing.

2.13 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

H. Spider system: All components consisting of Stainless steel grade 316, unless otherwise specified. Dimensions, types, sizes and finishes to be as selected by the engineer.

I. Cables, supports, tubes, pipes, bars, plates and the like to be made of Stainless steel grade 316, unless otherwise specified.

2.14 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

2.15 12 mm thick Tempered and laminated tinted glass balustrade with aluminum capping at top, for dimension refer to drawing and details.

2.16 12 mm thick frameless tempered glass partitionsand doors assembly type PG. For glass type FG at faced 10 mm thick tempered and tinted single glass to be used with powder coated aluminum frames.

2.17 Performance requirements of glass facade units (curtain walls), Doors and windows shall be as follows:

A. 6mm Tinted & Tempered outer glass + 12 mm A/S + 6mm inner clear glass

1. U-value (Summer): 2.8 W/m².C, maximum (EN 673)
2. Shading coefficient: 0.25, maximum (EN 410)
3. Light Transmittance: 40%.
4. Light reflectance: 11% to16%, in external position
5. Solar Heat Gain coefficient: (SHGC): 0.22

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 1270 mm as per manufacturer's recommendations.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 LOCK-STRIP GASKET GLAZING

A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system, unless otherwise indicated.

3.8 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.9 SANDBLASTING PATTERNS

A. Is to be factory-erected to dimensions, patterns and sizes indicated on Drawings. Lines of patterns are to be straight and neat, and intensity of sandblasting is to be uniform throughout pattern and pane. Match samples approved by the Engineer. Toughened glass is to be sandblasted prior to tempering process.

3.10 GLAZING SEALANT SCHEDULE

A. Medium-Modulus Neutral-Curing Silicone Glazing Sealant: Where glazing sealants of this designation are indicated, provide products recommended by glazing manufacturer.

1. Type and Grade: S (single component) and NS (nonsag).
2. Class: 25.
3. Additional Movement Capability: 50 percent movement in extension and 50 percent in compression for a total of 100 percent movement.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Glazing Substrates: M, G, A, and, as applicable to glazing substrates indicated O.
    a. Use O Glazing Substrates: Coated glass, color anodic aluminium, baked-enamel aluminium, galvanized steel, and wood.

B. High-Modulus Neutral-Curing Silicone Glazing Sealant: Where glazing sealants of this designation are indicated, provide products recommended by glazing manufacturer.

SECTION 088300 - MIRRORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes the following types of silvered flat glass mirrors.

1. Annealed monolithic glass mirrors with stainless steel frame.

B. Related Sections include the following:

1. Division 08 Section “Glazing”.
2. Division 05 Section “Metal Fabrications”
3. Division 06 Section “Interior architectural wood works”

1.3 DEFINITIONS

A. Deterioration of Mirrors: Defects developed from normal use that are attributable to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning mirrors contrary to mirror manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1.4 PERFORMANCE REQUIREMENTS

A. Provide mirrors that will not fail under normal usage. Failure includes glass breakage and deterioration attributable to defective manufacture, fabrication, and installation.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
2. Mirror hardware.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.

D. Samples: For each type of mirror product required, in the form indicated below:

1. Mirrors, 300 mm square, including edge treatment on 2 adjoining edges.
2. Mirror clips.
3. Mirror trim, 300 mm long.

E. Product Certificates: For each type of mirror, signed by product manufacturer.

F. Qualification Data: For Installer.

G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed mirror glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in mirror installations with a record of successful in-service performance.

B. Source Limitations for Mirrors: Obtain mirrors from one source for each type of mirror indicated.

C. Source Limitations for Mirror Glazing Accessories: Obtain mirror glazing accessories from one source for each type of accessory indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors, protected from moisture including condensation.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form, made out to Employer and signed by mirror manufacturer agreeing to replace mirrors that deteriorate as defined in "Definitions" Article, within specified warranty period indicated below:

1. Warranty Period: Ten years from date of Taking Over Certificate of the whole of the works.

PART 2 - PRODUCTS

2.1 SILVER FLAT GLASS MIRROR MATERIALS

A. Clear Glass Mirror: ASTM C 1503, Type I (transparent glass, flat), class, quality, and other properties as indicated below:

1. Clear Annealed Float Glass: Class 1 (clear), Quality q2 (mirror).
    a. Thickness: 6 mm, unless otherwise indicated.

2.2 MISCELLANEOUS MATERIALS

A. Mirror Frame: Shall be stainless steel Grade 316 as indicated on drawings

B. Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.

C. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

2.3 MIRROR HARDWARE

A. Mirror Top Clips: Stainless steel Grade 304 unless otherwise indicated on Drawings.

B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.4 FABRICATION

A. Mirror Sizes: To suit Project conditions, cut mirrors to final sizes and shapes.

B. Cutouts: Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Flat polished edge or beveled polished edge.

1. Seal edges of mirrors after edge treatment to prevent chemical or atmospheric penetration of glass coating.
2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance.

1. Verify compatibility with and suitability of substrates.
2. Proceed with mirror installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum air space of 3 mm between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. For wall-mounted mirrors, install mirrors with mirror hardware.

1. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
2. For metal or plastic clips, place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges.
3. Where indicated, install bottom trim and top clips. Fabricate bottom trim in single lengths to fit and cover bottom edges of mirrors. Locate top clips where indicated on Drawings.

3.3 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

SECTION 092400 - PORTLAND CEMENT PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Metal lath and accessories.
2. Portland cement plaster.
3. Refer to the finishing schedule for locations of applications.

1.3 SUBMITTALS

A. Product Data for each product specified.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Samples for verification in units at least 300 mm square of each type of finish indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.

D. Material Certificates: Submit certificate signed by manufacturer for each kind of plaster aggregate certifying that materials comply with requirements.

1.4 QUALITY ASSURANCE

A. Mockups: Prior to installing plaster work, construct panels for each type of finish and application required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Engineer.
2. Erect mockups 1200 by 1200 mm by full thickness in presence of the Engineer using materials, including lath, support system, and control joints, indicated for final Work.
3. Notify Engineer 7 days in advance of the dates and times when mockups will be constructed.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Engineer's approval of mockups before start of plaster Work.

6. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed portland cement plaster Work.
    a. When directed, remove mockups from Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver cementitious materials to Project site in original packages, containers, or bundles, labeled with manufacturer's name, product brand name, and lot number.

B. Store materials inside, under cover, and dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

1.6 PROJECT CONDITIONS

A. Environmental Requirements, General: Comply with requirements of referenced plaster application standards and recommendations of plaster manufacturer for environmental conditions before, during, and after plaster application. Comply with ASTM C 926 requirements.

B. Warm-Weather Requirements: Protect plaster against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial. Apply and cure plaster as required by climatic and job conditions to prevent dry out during cure period. Provide suitablecoverings, moist curing, barriers to deflect sunlight and wind, or combinations of these, as required.

C. Exterior Plaster Work: Do not apply plaster when ambient temperature is below 4 deg C.

D. Ventilation: Provide natural or mechanical means of ventilation to properly dry interior spaces after portland cement plaster has cured.

E. Protect contiguous work from soiling and moisture deterioration caused by plastering. Provide temporary covering and other provisions necessary to minimize harmful spattering of plaster on other work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work.

2.2 LATH

A. Expanded-Metal Lath: Comply with ASTM C 847 for material, type, configuration, and other characteristics indicated below.

1. Material: Fabricate expanded-metal lath from sheet metal conforming to the following:
    a. Galvanized Steel: Structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A 653M, Z275 minimum coating designation, unless otherwise indicated.

2. Diamond-Mesh Lath: Comply with the following requirements:
   a. Configuration: Coil.
      1) Minimum Weight: 1.1 kg/sq. m.

2.3 ACCESSORIES

A. General: Comply with material provisions of ASTM C 1063 and the requirements indicated below; coordinate depth of accessories with thicknesses and number of plaster coats required.
   1. Galvanized Steel Components (for internal plaster): Fabricated from zinc-coated (galvanized) steel sheet complying with ASTM A 653M, Z90 minimum coating designation.
   2. Stainless steel Components (for external plaster): Fabricated from stainless steel sheets to ASTM A666, alloy 316.

B. Metal Corner Reinforcement: Expanded, large-mesh, diamond-metal lath fabricated from zinc-alloy or welded-wire mesh fabricated from 1.2-mm- diameter, zinc-coated (galvanized) wire and specially formed to reinforce external corners of portland cement plaster while allowing full plaster encasement.

C. Metal Corner Reinforcement for external plaster: Expanded, large-mesh, diamond-metal lath fabricated from stainless steel type 316 and specially formed to reinforce external corners of portland cement plaster on exterior exposures while allowing full plaster encasement.

D. Cornerbeads: Small nose cornerbeads fabricated from the following metal, with expanded flanges of large-mesh diamond-metal lath allowing full plaster encasement.

E. Casing Beads: Square-edged style, with expanded flanges.

F. Control Joints: Prefabricated, of material and type indicated below:
   1. One-Piece Type: Folded pair of nonperforated screeds in M-shaped configuration, with expanded or perforated flanges.
   2. Two-Piece Type: Pair of casing beads with back flanges formed to provide slip-joint action, adjustable for joint widths from 3 to 16 mm.
      a. Provide removable protective tape on plaster face of control joints.

G. Lath Attachment Devices: Material and type required by ASTM C 1063 for installations indicated.

H. Foundation Sill (Weep) Screed: Manufacturer's standard profile designed for use at sill plate line to form plaster stop and prevent plaster from contacting damp earth, fabricated from zinc-coated (galvanized) steel sheet.

2.4 PLASTER MATERIALS

A. Base-Coat Cements: Type as indicated below:
   1. Portland cement, ASTM C 150, Type I.

B. Job-Mixed Finish-Coat Cement: Material and color as indicated below:

1. Portland cement, sand aerated mix.
2. Cement Color: Gray.

C. Single Coat Ready Mix Rush-Coat: To BS 4551 : Part 2: 1998, ASTM C 150, ASTM C 926, ASTM C 897, DTU 26.1.

D. Single Coat Ready Mix Plaster: To BS 4551 : Part 2: 1998, ASTM C 150, ASTM C 926, ASTM C 897, DTU 26.1, with the following technical characteristics:

1. Initial adhesion :> 0.3 MPa @ 28 days
2. Flexural strength : 3 ± 1 MPa
3. Density of hardened product : 1.8 ± 0.1
4. Compressive strength : 10 ± 2 MPa @ 28 days

E. Admixtures: Water-retaining admixture and air-entraining admixtures to ASTM C260 as a workability aids.

F. Pigments: Cement mortar pigments to BS EN 12878.

G. Waterproofing Additive: shall be a formulation of acrylic polymer and modifiers in a water based emulsion designed for use as admixture and shall be approved by the Engineer.

H. Factory-Prepared Finish Coat: Manufacturer's standard factory-packaged blend of portland cement, ASTM C 150, Type I; aggregate, ASTM C 897; suitable admixtures, and compatible with base coat and finish texture.

I. Lime: Do not use lime.

J. Sand Aggregate for Base Coats: ASTM C 897.

K. Aggregate for Finish Coats: ASTM C 897 system and as indicated below:

1. Manufactured or natural sand, white in color.

2.5 MISCELLANEOUS MATERIALS

A. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 13 mm long, free of contaminates, manufactured for use in portland cement plaster.

B. Water for Mixing and Finishing Plaster: Potable.

C. Bonding Agent: ASTM C 932.

D. Acid-Etching Solution: Muriatic acid (10 percent solution of commercial hydrochloric acid) mixed 1 part to not less than 6 nor more than 10 parts water.

E. Dash-Coat Material: 2 parts portland cement to 3 parts fine sand, mixed with water to a mushy-paste consistency.

2.6 PLASTER MIXES AND COMPOSITIONS

A. General: Comply with ASTM C 926 for base- and finish-coat mixes as applicable to plaster bases, materials, and other requirements indicated.

B. Fiber Content: Add fiber to following mixes after ingredients have mixed at least 2 minutes. Comply with fiber manufacturer's written instructions but do not exceed 16 kg/cu. m of cementitious materials. Reduce aggregate quantities accordingly to maintain workability.

C. Spatter dash Coat: Apply spatter dash coat to all concrete and masonry masonry unit surfaces and allow drying thoroughly

D. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:

1. Portland Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and 2-1/2 to 4 parts aggregate per part of cementitious material.

b. Brown Coat: For cementitious material, mix 1 part portland cement and 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

E. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows:

1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 2-1/2 to 4 parts aggregate per part of cementitious material.

F. Job-Mixed Finish-Coat Mixes:

1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 1-1/2 to 3 parts aggregate per part of cementitious material.

G. Factory-Prepared Finish-Coat Mixes: Add water only for ready-mixed finish-coat plasters, comply with manufacturer's written instructions.

2.7 MIXING

A. Manual mixing is prohibited.

B. Mechanically mix cementitious and aggregate materials for plasters using electrical mixers to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

C. All tools, mixers and mixing boxes shall be cleaned after mixing each batch and kept free of plaster from previous mixes; strict precautions shall be taken to avoid the plasters or other materials becoming contaminated by pieces of partially set materials.

PART 3 - EXECUTION

3.1 PREPARATIONS FOR PLASTERING

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

B. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

C. Clean plaster bases and substrates for direct application of plaster, removing loose material and substances that may impair the Work.

D. Etch concrete and concrete unit masonry surfaces indicated for direct plaster application. Scrub with acid-etching solution on previously wetted surface and rinse thoroughly with clean water. Repeat application, if necessary, to obtain adequate suction and mechanical bond of plaster (where dash coat, bonding agent, or additive is not used).

E. Apply bonding agent on concrete and concrete unit masonry surfaces indicated for direct plaster application; comply with manufacturer's written instructions for application.

F. Apply dash coat on concrete surfaces indicated for direct plaster application. Moist-cure dash coat for at least 24 hours after application and before plastering.

G. Install temporary grounds and screeds to ensure accurate rodding of plaster to true surfaces; coordinate with scratch-coat work.

H. Surface Conditioning: Immediately before plastering, dampen concrete and concrete unit masonry surfaces that are indicated for direct plaster application, except where a bonding agent has been applied. Determine and apply amount of moisture and degree of saturation that will result in optimum suction for plastering.

I. The vertical surfaces shall be covered with plaster guides spaced one meter apart and set-up true to plumb and string (The plaster guides shall be surfaced with small ceramic tiles cut pieces).

3.2 INSTALLATION OF LATH AND FURRING, GENERAL

A. Standards: Comply with requirements of ASTM C 1063.

B. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, handrails, furnishings, and similar work to comply with details indicated or, if not otherwise indicated, to comply with applicable written instructions of lath and furring manufacturer.

C. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition or wall abuts overhead structure, sufficiently isolate from structural movement to prevent transfer of loading from building structure. Install slip- or cushion-type joints to absorb deflections but maintain lateral support.

1. Frame both sides of control joints independently and do not bridge joints with furring and lathing or accessories.

D. Install additional framing, furring, runners, lath, and beads, as required to form openings and frames for other work as indicated. Coordinate support system for proper support of framed work that is not indicated to be supported independently of metal furring and lathing system.

1. The Contractor shall apply to all surface cracks and passages of electrical conduits, expanded metal lath covering at least 10 cm to the left and to the right of the crack’s edges. The angles / corners shall be reinforced with galvanised mild steel corner beads full height one piece long, set up true to plumb, without any distortion and

kinks, securely plugged, nailed, or stapled at internals not exceeding 450 mm at both edges.

3.3 LATHING

A. Install metal lath for the following applications where plaster base coats are required. Provide appropriate type, configuration, and weight of metal lath selected from materials indicated that comply with ASTM lathing installation standards.

1. Dissimilar Backgrounds: where rendering is to be continued without break across joints between dissimilar solid backgrounds which are in the same plane and rigidly bonded or tied together, cover joints with 150mm wide strip of building paper overlaid with 300mm wide galvanized steel lathing fixed at not more than 600 mm centers along both edges.

3.4 INSTALLATION OF PLASTERING ACCESSORIES

A. General: Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and in alignment during plastering. Install accessories of type indicated at following locations:

1. External Corners: Install corner reinforcement at external corners.
2. Terminations of plaster: Install casing beads, unless otherwise indicated.
3. Control Joints: Install at locations indicated or, if not indicated, at locations complying with the following criteria and approved by Engineer:
   a. Where an expansion or contraction joint occurs in surface of construction directly behind plaster membrane.
   b. Distance between Control Joints: Not to exceed 5.4 m in either direction or a length-to-width ratio of 2-1/2 to 1.
   c. Wall Areas: Not more than 13 sq. m.
   d. Horizontal Surfaces: Not more than 9 sq. m in area.
   e. Where plaster panel sizes or dimensions change, extend joints full width or height of plaster membrane.

3.5 PLASTER APPLICATION

A. Plaster Application Standard: Apply plaster materials, composition, and mixes to comply with ASTM C 926.

B. Do not use materials that are frozen, caked, lumpy, dirty, or contaminated by foreign materials.

C. Do not use excessive water in mixing and applying plaster materials.

D. Flat Surface Tolerances: Do not deviate more than plus or minus 3 mm in 3 m from a true plane in finished plaster surfaces, as measured by a 3-m straightedge placed at any location on surface.

E. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, and before lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 152 mm at each jamb anchor.

F. Sequence plaster application with installation and protection of other work so that neither will be damaged by installation of other.

G. Plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where interior plaster is not terminated at metal frame by casing beads, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.

H. Corners: Make internal corners and angles square; finish external corners flush with cornerbeads on interior work, square and true with plaster faces on exterior work.

I. Number of Coats: Apply plaster of composition indicated, to comply with the following requirements:

1. Two Coats: Over the following plaster bases:
    a. Concrete unit masonry.
    b. Concrete, cast-in-place or precast when surface condition complies with ASTM C 926 for plaster bonded to solid base.
2. For plaster thickness less or equal than 15 mm, the plaster works shall be applied in one coat, in addition to spatter-dash, unless otherwise specified
3. For plaster thickness greater than 15 mm, the plaster works shall be applied in two or three coats, in addition to spatter-dash, unless otherwise specified. The first coat has to be rough finished and completely cured for 3 days before the second coat is applied on top of it, and the third (if it does exist) is applied in the same manner.

J. Finish Coats: Apply finish coats to comply with the following requirements:

1. Float Finish: Apply finish coat to a minimum thickness of 3 mm to completely cover base coat, uniformly floated to a true even plane with fine-textured finish matching Engineer's sample approved by Engineer.
2. Trowel-Textured Finish: Apply finish coat with hand-troweled-textured finish matching Engineer's sample approved by Engineer.
3. Dash Finish: Machine-apply finish-coat plaster in 2 coats evenly and uniformly to produce textured finish matching sample approved by Engineer.
4. Prepared Finish: Apply stucco finish coats, acrylic-based finish coats, and other factory-prepared finish coats according to manufacturer's written instructions.

K. The succeeding coats (if thickness is above 15 mm) shall be spaced of at least three days work for curing and hardening, and carried out in one operation between two corners, including the reveals for jambs and lintels

L. Total Nominal Thickness of Plaster: Excluding dash-coat, apply plaster to the following total thickness:

1. Internal Plaster: 15mm or 20, as shown on Drawings.
2. Plaster on Metal Lath: 15mm finish and base coats over scratch coat of thickness as required to completely fill and block interstices of metal lath.

M. Ready-mix plaster powder shall be mechanically mixed with clean, cold water prior to use, to a uniform creamy and lump-free consistency.

N. Moist-cure plaster base and finish coats to comply with ASTM C 926, including written instructions for time between coats and curing in "Annex A2 Design Considerations."

O. Plaster on walls shall be done up to 100 mm above the false ceiling level, unless otherwise specified.

3.6 CUTTING AND PATCHING

A. Cut, patch, replace, repair, and point up plaster as necessary to accommodate other work. Repair cracks and indented surfaces. Point-up finish plaster surfaces around items that are built into or penetrate plaster surfaces. Repair or replace work to eliminate blisters, buckles, check cracking, dry outs, efflorescence, excessive pinholes, and similar defects. Repair or replace work as necessary to comply with required visual effects.

3.7 CLEANING AND PROTECTING

A. Remove temporary covering and other provisions made to minimize spattering of plaster on other work. Promptly remove plaster from door frames, windows, and other surfaces not to be plastered. Repair surfaces stained, marred or otherwise damaged during plastering work. When plastering work is completed, remove unused materials, containers, equipment, and plaster debris.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure plaster work is without damage or deterioration at the time of Substantial Completion.

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes the following:

1. Suspended gypsum board ceilings and bulkheads.
2. Gypsum board access panels.
3. Gypsum board wall panels.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 5 Section "Metal Fabrications”.
2. Division 7 Section "Joint Sealants".
3. Division 9 Section "Interior Painting”.
4. Division 9 Section “Stretched Fabric Wall Systems”.

1.3 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

A. Product Data: For each type of product specified.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Installer Experience: List of five projects (minimum) of same type and standard of quality successfully erected by the installer with the same product.

D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of Engineers and Employers, and other any information required by the Engineer.

E. Shop Drawings: Showing locations, fabrication, and installation of control and expansion joints including reflected ceiling plans, sections, details of components, and attachments to other units of Work.

F. Samples: For the following products:

1. Trim Accessories: Full-size sample in 300-mm-long length for each trim accessory indicated.

G. Product Certificates: Signed by manufacturers of gypsum board assembly components certifying that their products comply with specified requirements.

H. Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer's representative.

I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Acoustical assemblies tested to BS EN ISO 140 (Previous BS 2750) and BS EN ISO 717 are accepted.

D. Installer Qualifications: A qualified firm specializing in performing the work of this Section with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Engineers and Employers, and other information specified.

E. Single-Source Responsibility for Gypsum Boards and Steel Framing: Obtain each type of gypsum board and other panel products and steel framing from a single manufacturer.

F. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to the gypsum board manufacturer.

G. Mockups: Prior to finishing gypsum board assemblies, construct mockups of at least 9 sq. m in surface area to demonstrate aesthetic effects of finishes as well as qualities of materials and execution. Simulate finished lighting conditions for review of in-place unit of Work.

1. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.
   a. Locate mockups on site in the location and of the size indicated or, if not indicated, as directed by the Engineer.
   b. Notify the Engineer one week in advance of the dates and times when mockups will be constructed.
   c. Demonstrate the proposed range of aesthetic effects and workmanship.
   d. Obtain the Engineer's approval of mockups before start of final unit of Work.

e. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

f. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

C. Handle steel framing materials in a manner not to cause bending or denting of sections.

1.7 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are closed and conditioned.

C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of Gypsum board ceiling systems and acoustical panels that fail in performance, materials, or workmanship within specified warranty period.

1. Warranty Period: 10years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Lafarge
2. Knauf
3. Or approved equal

2.2 STEEL FRAMING COMPONENTS FOR SUSPENDED CEILINGS

A. General: Provide components complying with ASTM C 754 for conditions indicated.

B. Postinstalled Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials, with holes or loops for attaching hanger wires, and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing according to ASTM E 488 conducted by a qualified independent testing agency.

1. Expansion anchor.

C. Wire Ties: ASTM A 641M, Class 1 zinc coating, soft temper, 1.6 mm thick, unless otherwise shown on Drawings.

D. Hanger Rods: Mild steel and zinc coated or protected with rust-inhibitive paint.

E. Flat Hangers: Mild steel and zinc coated or protected with rust-inhibitive paint.

F. Angle-Type Hangers: Angles with legs not less than 22.2 mm wide, formed from 1.6-mm-thick galvanized steel sheet complying with ASTM A 653M, Z 180 coating designation, with bolted connections and 8 mm diameter bolts.

G. Channels: Cold-rolled steel, , as follows:

H. Carrying and Furring Channels: dimensions shall be as shown on Drawings.

1. Finish: ASTM A 653M, Z 180 hot-dip galvanized coating.

I. Grid Suspension System for Interior Ceilings: ASTM C 645, manufacturer's standard direct-hung grid suspension system composed of main beams and cross-furring members that interlock to form a modular supporting network.

2.3 INTERIOR GYPSUM BOARD CEILINGS

A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to gypsum board indicated and whichever is more stringent.

B. Gypsum board shall be plain gypsum board ceiling type having a high sag resistance, 12.5mm thick unless indicated otherwise anchored to suspension system with no apparent joints.

1. Long Edges: Tapered.

C. Water-Resistant Gypsum Board: ASTM C 630 and as follows:

1. Type: Regular, unless otherwise indicated.
2. Thickness: 12.5 mm, unless otherwise indicated.
3. Water Absorption: 10% max.
4. Use for application in wet areas and where indicated on Drawings or specified.

2.4 EXTERIOR GYPSUM BOARD CEILINGS

A. Exterior Gypsum Soffit Board: ASTM C931/C 931M or ASTM C 1396/C 1396M, with manufacturer’s standard edges. Core: 12.5mm, regular type.

2.5 STEEL FRAMING COMPONENTS FOR WALL PANEL ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.

1. Hot-dip galvanized steel.
2. Minimum Base-Metal Thickness: 0.6mm or as indicated on the drawings.
3. Depth: as indicated on the drawings.

B. Cold-Rolled Channels at Top and Bottom: hot-dip galvanized steel, 1.37mm bare-steel thickness with minimum 50.8mm wide flanges.

C. Fire Stop Tracks, where required: Top runner manufactured to allow wall panel head to expand and contract with the movement of the structure while maintaining continuity of fire-resistance rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

D. Fasteners for Metal Framing: Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing securely to substrates involved, complying with the recommendations of gypsum board manufacturers for application indicated.

2.6 GYPSUM BOARD WALL PANELS

A. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in the area indicated to receive gypsum board application.

B. Gypsum Wall Board: ASTM C 36 and as follows:

1. Types: Regular, unless otherwise indicated.
2. Edges: Tapered.
3. Thickness: as indicated on Drawings.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:

1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

B. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

2.8 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.

B. Joint treatment tape: complying with ASTM C475.

C. Steel drill screws complying with ASTM C 1002 for the following applications:

1. Fastening gypsum board to steel members less than 0.84 mm thick.

D. Steel drill screws complying with ASTM C 954 for fastening gypsum board to steel members from 0.84 to 2.84 mm thick.

E. Steel drill screws of size and type recommended by manufacturer for fastening gypsum boards to timber frames.

F. Foam Gaskets: Closed-cell vinyl foam adhesive-backed strips that allow fastener penetration without foam displacement, 3.2 mm thick, in width to suit metal stud size indicated.

G. Sound-Attenuation Blankets: Unfaced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).

1. Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.

2. Blanket is to be 40 mm thick, 60 kg/m3 intensity, minimum.

3. Where ceiling plenum is used for air condition return, use sound blanket with foil scrim facing and set with facing at upper side in the as-installed position.

4. Use sound attenuation blankets where indicated or directed by the Engineer to attain sound attenuation performance.

5. Sound Transmission class: ASTM E90.

6. Manufacturer: IROC or approved equal.

H. Acoustical Sound Absorptive Gypsum Board.

1. Perforated gypsum panels with 15.5% perforation.

2. Perforation pattern: to the Engineer selection.

3. Perforation thickness: to the Engineer selection.

4. NRC: Not less than 0.7.

5. Humidity Resistance: 95% Rh

6. Sound Attenuation: 43 db.

7. Thickness: 13 mm, unless otherwise indicated.

8. All over the false ceiling boards a layer of 100 mm thick mineral wool insulation, (minimum density of 60kg/m^3 unless otherwise indicated on drawings) sealed in a polythene sleeves shall be laid.

   a. Provide sound-attenuating materials with a flame spread index of 0 and smoke developed index of 0 when tested per ASTM E 84.

9. Gypsum board on a metal frame grid shall be suspended from the underside of the structural soffit on acoustic resilient hangers.

10. All openings or penetrations through ceiling or roof slab shall be properly acoustically sealed according to manufacturer requirement and approved of the Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with the Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Ceiling Anchorages: Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

3.3 INSTALLING STEEL FRAMING FOR SUSPENDED CEILINGS

A. Suspend ceiling hangers from building structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
4. Secure flat, angle, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or otherwise fail.
5. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to steel deck tabs.
7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Sway-brace suspended steel framing with hangers used for support.

C. Install suspended steel framing components in sizes and at spacings recommended by manufacturer, but not less than that required by the referenced steel framing installation standard.

1. Wire Hangers: 1200 mm o.c.

2. Carrying Channels (Main Runners): 1200 mm o.c.

3. Furring Channels (Furring Members): 400 mm o.c.

D. Installation Tolerances: Install steel framing components for suspended ceilings so that cross-furring or grid suspension members are level to within 3 mm in 3.6 m as measured both lengthwise on each member and transversely between parallel members.

E. Wire-tie or clip furring members to main runners and to other structural supports as indicated.

3.4 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840.

B. Install sound-attenuation blankets, where indicated, prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

3.5 FIELD QUALITY CONTROL

A. Above-Ceiling Observation: The Engineer will conduct an above-ceiling observation prior to installation of gypsum board ceilings and report any deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.

1. Notify the Engineer one week in advance of the date and the time when the Project, or part of the Project, will be ready for an above-ceiling observation.

2. Prior to notifying the Engineer, complete the following in areas to receive gypsum board ceilings:

a. Installation of 80 percent of lighting fixtures, powered for operation.

b. Installation of insulation, and leak and pressure testing of water piping systems.

c. Installation of air duct systems.

d. Installation of air devices.

e. Installation of mechanical system control air tubing.

f. Installation of ceiling support framing.

3.6 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner acceptable to the Installer, that ensure that gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.

SECTION 093000 - TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes the following:

1. Mass anti-slip ceramic floor tiles.
2. Glazed ceramic wall tile.
3. Terrazzo tiles (wherever required)
4. Refer to the finishing schedule for locations of applications

B. Related Sections include the following:

1. Division 7 Section "Joint Sealants".
2. Division 7 all sections related to waterproofing.
3. Division 9 Section "Portland Cement Plaster".

1.3 DEFINITIONS

A. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.

B. Facial Dimension: Actual tile size (minor facial dimension as measured per ASTM C 499).

1.4 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6.
2. Ramps: Minimum 0.8.

B. Load-Bearing Performance: For ceramic tile installed on walkway surfaces, provide installations rated for the following load-bearing performance level based on testing assemblies according to ASTM C 627 that are representative of those indicated for this Project. Use these classifications as shown on Drawings or directed by Engineer:

1. Extra Heavy: Passes cycles 1 through 14.
2. Moderate: Passes cycles 1 through 10.

1.5 SUBMITTALS

A. Product Data: For each type of tile, mortar, grout, and other products specified.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

C. Shop Drawings: For the following:

1. Tile patterns and locations.
2. Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Tile Samples for Initial Selection: Manufacturer's color charts consisting of actual tiles or sections of tiles showing the full range of colors, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving color selection.

E. Samples for Verification: Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal color and texture variations, include Sample sets showing the full range of variations expected.

1. Each type and composition of tile and for each color and texture required, at least 300 mm square, mounted on braced cementitious backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Engineer.
2. Full-size units of each type of trim and accessory for each color required.
3. Metal edge strips in 150-mm lengths.

F. Product Certificates: Signed by manufacturers certifying that the products furnished comply with requirements.

G. Product certificate of origin.

H. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of the Engineers and owners, and other information specified.

I. Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.

J. Test Reports: Material test reports from qualified independent testing laboratory indicating and interpreting test results relative to compliance of tile and tile setting and grouting products with requirements indicated.

K. Setting Material Test Reports: Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

L. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Source Limitations for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.

C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer

D. Source Limitations for Other Products: Obtain each product specified in this Section from one source and by a single manufacturer.

E. Mockups: Before installing tile, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed Work.

1. Locate mockups in the location and of the size indicated or, if not indicated, as directed by Engineer.
2. Notify Engineer 7 days in advance of the dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Engineer's approval of mockups before proceeding with final unit of Work.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
    a. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

F. Preinstallation Conference: Conduct conference at Project sit.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

C. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard for materials and workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CERCOM (Carbone and Cenere)
2. Or approved equal

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
2. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.
3. Tiles are to be highest grade of production in manufacturer’s quality grading system.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.

C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

1. Provide Engineer's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.
2. Provide tile trim and accessories that match color and finish of adjoining flat tile, unless directed by the Engineer.

D. Factory Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.

E. Mounting: Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.

2.3 TILE PRODUCTS

A. General Tile Characteristics: Tiles are to comply with the following general requirements:

1. Anti slip Ceramic Floor and Wall Tiles, (1st choice, heavy duty, unglazed rectified tiles, Full body):
   a. Abrasive Hardness: Minimum Index 253 to ASTM C 501.
   b. Bending Strength: Minimum 35 N/mm2 to ASTM C 648 or BS EN ISO 10545.
   c. Breaking strength ≥ 450lbs to ASTM C648 or BS EN ISO 10545.
   d. Resistance to deep abrasion: ≤ 150mm³ to ASTM C1243 or BS EN ISO 10545.
   e. Scratch resistance: 7 to Mohs scale.
   f. Dry coefficient of friction: 0.6 minimum to ASTM C1028.
   g. Water Absorption: Less than 0.5% to ASTM C 373 or BS EN ISO 10545.
   h. Linear thermal expansion coefficient: $6.9x10^{-6}$ C-1.
   i. Thermal shock resistance: resistant.
   j. Frost resistance: frost proof.
   k. Resistance to chemical attack: class UA- ULA-UHA.
   l. Provide non-slip treatment for all floor tiles.
   m. Slip resistance: R10 for corridors, stairs and sanitary rooms and R11 for kitchens, labs and service rooms.
2. Base Tiles (skirting)
   a. Same material as floor tiles.
   b. Shape: coved, chamfered or right angle edge, as shown on Drawings or selected by the Engineer.
3. Face: Smooth / Rough or Textured, as selected by the Engineer.
4. Facial Dimensions: As indicated on Drawings.
5. Thicknesses: Minimum 10 mm for floors and walls, unless otherwise specified.
6. The tile shall have color fastness for all colors.
7. Shade variation: Class V2.

2.4 TERRAZO TILES

A. Face: Smooth to receive vinyl or other material as shown on drawing, and as selected by the Engineer.

B. Facial Dimensions: As indicated on Drawings.

C. Thicknesses: Minimum 20 mm for floors, unless otherwise specified.

2.5 SETTING MATERIALS

A. Portland Cement Mortar Installation Materials: Provide materials complying with ANSI A108.1A and as specified below:

1. Latex additive (water emulsion) described below, serving as replacement for part or all of gauging water, of type specifically recommended by latex additive manufacturer for use with job-mixed portland cement and aggregate mortar bed.

b. Latex Additive: Styrene butadiene rubber.

B. Latex-Portland Cement Mortar: ANSI A118.4, composed as follows:

1. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of prepackaged dry-mortar mix and liquid-latex additive complying with the following requirements:

c. Latex Additive: Styrene butadiene rubber.

a. For wall applications, provide nonsagging, latex-portland cement mortar complying with ANSI A118.4.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

d. Laticrete International, Inc or approved equal.

C. Semi Dry Mortar Mix and Latex Additive: Mixture of prepackaged dry-mortar mix and liquid-latex additive consisting of 1 part ordinary Portland cement and 3-4 parts sand (by volume). Use Latex Additive as per manufacturer's printed recommendations.

1. Latex Additive: Styrene butadiene rubber.

D. Chemical-Resistant, Water-Cleanable, Ceramic Tile-Setting and -Grouting Epoxy: ANSI A118.3.

E. Tile Adhesive to concrete substrate: cement based tile adhesive. Comply with the following requirements:

1. Tensile Adhesion Strength: 1.1 MPa minimum according to EN 1348.

2. Shear Strength: 1.8 MPa minimum according to ANSI 118.4.

F. Tiles Adhesive to Steel and Wood Substrate: Non-Sag epoxy, thixotropic epoxy adhesive. Comply with the following requirement:

1. Shear Bond strength: 7.8 MPa, minimum according to ANSI A118.3

2. Compressive Strength: 55.2 MPa, minimum according to ANSI A118.3.

3. Tensile Strength: 25.3 MPa, minimum according to ASTM D638.

4. Light non-staining color.

G. Adhesive Manufacturers: Mapei or approved equal.

2.6 GROUTING MATERIALS

A. Latex-Portland Cement Grout: ANSI A 118.6 composed as follows:

1. Factory-Prepared, Dry-Grout Mixture: Factory-prepared mixture of portland cement; dry, redispersible, ethylene vinyl acetate additive; and other ingredients which only water must be added at Project Site.

B. Chemical-Resistant Epoxy Grout: ANSI A 118.3, color as indicated.

1. Provide product capable of resisting continuous and intermittent exposure to temperatures of up to 60 deg C and 100 deg C, respectively, as certified by mortar manufacturer for intended use.

C. Grout Colors: Provide colors as selected by the Engineer from manufacturer's full range of standard and custom colors. Finish shall be smooth, unless otherwise specified or directed by the Engineer.

2.7 ELASTOMERIC SEALANTS

A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements of Division 7 Section "Joint Sealants."

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant (for joints in nontraffic surfaces): ASTM C920; Type S; Grade NS; Class 25; USE NT; G, A, and as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

D. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.

E. Available Products: Subject to compliance with requirements, products which may be incorporated into the Work include, but are not limited to, the following:

1. One-Part, Mildew-Resistant Silicone Sealants:
   e. Dow Corning Corporation or approved equal.
2. Multipart, Pourable Urethane Sealants:
   a. Mameco International, Inc.
   b. Tremco, Inc.
   c. Or approved equal

2.8 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland-cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.9 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.
2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust latter in consultation with Engineer.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds, and other substances that contain soap, wax, oil, or silicone and are incompatible with tile-setting materials by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.

B. Provide concrete substrates for tile floors installed with dry-set or latex-portland cement mortars that comply with flatness tolerances specified in referenced ANSI A108 series of tile installation standards for installations indicated.

1. Use trowelable leveling and patching compounds per tile-setting material manufacturer's written instructions to fill cracks, holes, and depressions.
2. Remove protrusions, bumps, and ridges by sanding or grinding.

C. Provide substrates for wall tile installed with adhesive that comply with flatness tolerances specified in referenced ANSI A108 series of tile installation standards for installations indicated.

1. Use cement plaster, with expanded mesh reinforcement where necessary, and patching compounds per tile-setting material manufacturer's written instructions to fill cracks, holes, and depressions.

D. Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, verify that tile has been blended in the factory and packaged so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

E. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent adhesion or staining of exposed tile surfaces by grout, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of temporary protective coating indicated below, taking care not to coat unexposed tile surfaces:

1. Petroleum paraffin wax, applied hot.
2. Grout release.
3. Petroleum paraffin wax or grout release.

F. Waterproofing Under Floor Tile Installation in Wet Areas: Comply with requirements as specified in Division 7.

3.3 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 series of tile installation standards in "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation.

B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.

C. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are the same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.

F. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Locate joints in tile surfaces directly above joints in concrete substrates.
2. Prepare joints and apply sealants to comply with requirements of Division 7 Section "Joint Sealants."

G. Grout tile to comply with the requirements of the following tile installation standards:

1. For tile grouts (sand-portland cement, dry-set, commercial portland cement, and latex-portland cement grouts), comply with ANSI A108.10.

3.4 FLOOR TILE INSTALLATION

A. General: Install tile to comply with requirements in the Ceramic Tile Floor Installation Schedule and ANSI A108 series of tile installation standards.

B. Joint Widths: Install tile on floors with the following joint widths:

1. Ceramic Floor Tile: 3.0 mm, unless otherwise shown on Drawings.

C. Ceramic Floor Tile: Install tile to comply with requirements indicated below for setting-bed method, TCA installation method related to types of subfloor construction, and grout types:

1. Latex-Portland Cement Mortar: ANSI A108.5.
2. Concrete Subfloor, Interior: TCA F113.
3. Grout: Chemical resistant epoxy grout.

D. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

3.5 WALL TILE INSTALLATION

A. Install types of tile designated for wall installations to comply with requirements in the Ceramic Tile Wall Installation Schedule and ANSI setting-bed standards.

B. Install metal lath and scratch coat to walls to comply with ANSI A108.1A, Section 4.1.

C. Joint Widths: Install tile on walls with the following joint widths:

1. Wall Tile: 1.6 mm, unless otherwise shown on Drawings.

D. Back Buttering: For installations indicated, obtain 100 percent adhesive coverage by complying with applicable special requirements for back buttering of tile in referenced ANSI A108 series of tile installation standards:

E. Set and grout ceramic tiles with epoxy adhesive and grout material on Portland cement plaster base coats in Division 9, Section "Portland Cement Plaster" applied onto scratch coat as specified in same section.

3.6 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove epoxy and latex-portland cement grout residue from tile as soon as possible.
2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.
3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to brick and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.

C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, that ensure tile is without damage or deterioration at the time of Substantial Completion.

1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
2. Prohibit foot and wheel traffic from tiled floors for at least 7 days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

SECTION 095423- LINEAR METAL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including COPA and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes aluminum strips and suspension systems for ceilings.

B. Products furnished, but not installed under this Section, include anchors, rods, clips, aluminum L angle and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension system members.

2. Method of attaching hangers to building structure.

3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Samples for Initial Selection: For components with factory-applied color finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

1. Aluminum strips: Set of 300-mm- long Samples of each type, color, pattern, and texture.

2. Exposed Suspension System Members, Moldings, and Trim: Set of 300-mm- long Samples of each type, finish, and color.

F. Qualification Data: For testing agency.

G. Field quality-control test reports.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum strips ceiling.

I. Research/Evaluation Reports: For aluminum strips ceiling and components.

J. Maintenance Data: For finishes to include in maintenance manuals.

K. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.

B. Source Limitations: Obtain each set of aluminum strips and suspension systems through one source from a single manufacturer with resources to provide products of consistent quality in appearance, physical properties, and performance.

C. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A materials, as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction

D. Seismic Standard: Provide linear metal ceilings designed and installed to withstand the effects of earthquake motions according to the requirements of other sections in the Specifications.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver linear metal pans , suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle linear metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install linear metal ceilings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.7 COORDINATION

A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of aluminum strips ceiling systems that fail in performance, materials, or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Dobner;

B. Or approved equal.

2.2 ALUMINIUM STRIPS SUSPENDED CEILING

A. Aluminum Strips:

1. Provide perforated strips where shown on Drawings.

2. Strip width: as shown on Drawings.

3. Strip Thickness: as per manufacturer requirement and approved Engineer.

4. Height: as shown on drawings and/or as per manufacturer requirement and approved Engineer.

5. Fire resistance: Class 0 fire rating & BS 476.

6. Finishes and textures: as recommended by finish manufacturer for type of use and finish indicated and to the Engineer approval.

B. Sound absorption of aluminum strips suspended ceiling: approx. 0.50 noise reduction coefficients.

C. Acoustical insulation: 0.2 mm thick acoustic non-woven fabric, black or white color, should be installed.

D. Shop cut: to accommodate mechanical and electrical items.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension Systems Standard: Provide ceiling manufacturer's standard metal suspension systems of types and finishes indicated that comply with applicable ASTM C 635 requirements.

B. Suspension Systems: Provide systems complete with steel channels, galvanized steel carriers, splice sections, connector clips, alignment clips, leveling clips, galvanized threaded rod hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, brass anchors, galvanized screws, plastic anchors, nail plugs and other suspension components required to support ceiling units and other ceiling-supported construction.

C. Internal and External corners: Of the same material, thickness finishes, and performed to profile to match exposed linear panels.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

D. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

E. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.

3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.

4. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 2.69-mm- diameter wire.

F. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

G. Angle Hangers: Angles with legs not less than 22 mm wide; formed with 1-mm- thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90coating designation; with bolted connections and 8-mm- diameter bolts.

H. Carriers: Factory finished .

1. Main Carriers: Aluminum, not less than 6.0mm rolled sheet, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, complying with ASTM B 209 (ASTM B 209M).

2. Main Carriers: Steel, not less than 0.53-mm nominal thickness, cold-rolled sheet, with factory-applied protective coating, complying with ASTM C 635.

a. Electrolytic Zinc-Coated Steel: ASTM A 591/A 591M.
b. Hot-Dip Galvanized Steel: ASTM A 653/A 653M.

3. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.

4. Flexible Radial Carriers: Manufacturer's standard radial carriers.

5. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.

I. Carrier Splices: Same metal, profile, and finish as indicated for carriers.

J. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers at regular intervals and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated; and factory finished with matte-black baked finish.

K. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

L. Exterior Bracing Channels and Angles: Cold-rolled steel, hot-dip galvanized to comply with ASTM A 653/A 653M, G60 (Z180) coating designation; size and profile as required to withstand wind load.

M. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.

2.4 ALUMINUM FINISHES

A. Two layers of polyesterpaint finish of minimum thickness of 20 microns, one side with a full primer and finish coat, the other side with a primer coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of linear metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install linear metal ceilings to comply with seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counters playing, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.

5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

8. Do not attach hangers to steel deck tabs.

9. Do not attach hangers to steel roof deck. Attach hangers to structural members.

10. Space hangers not more than 1200 mmo.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 200 mm from ends of each member.

11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.

1. Screw attach moldings to substrate at intervals not more than 400 mmo.c. and not more than 75 mm from ends, leveling with ceiling suspension system to a tolerance of 3.2 mm in 3.6 m. Miter corners accurately and connect securely.

2. Do not use exposed fasteners, including pop rivets, on moldings and trim

E. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.

G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.

1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.

2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.

3. Install pans with butt joints using internal pan splices.

4. Install directionally textured metal pans in directions indicated.

5. Where metal pan ends are visible, install end caps unless trim is indicated.

6. Install filler strips where indicated.

7. Install sound-absorbent fabric layers in perforated metal pans.

8. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.

H. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections and prepare reports:

1. Suspended ceiling system.

2. Hangers, anchors and fasteners.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

C. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.

a. Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 890 N of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 1957 N of tension.

D. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency

E. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports

3.5 CLEANING

A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

SECTION 096340 - STONE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including COPA.

1.2 SUMMARY

A. This Section includes the following

1. Dimension Stone, Threshold and Sill.
2. Dimension stone stair treads and risers, skirting and thresholds.
3. Terrazzo flooring.
4. Refer to the finishing schedule for locations of application.

B. Related Sections include the following:

1. Division 7 Section "Joint Sealants".

1.3 PERFORMANCE REQUIREMENTS

A. Stone Abrasion Resistance: Minimum value of 12, based on testing according to ASTM C 241 or ASTM C 1353, unless a higher value is required by the referenced building stone standard.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each variety of stone. Include data on physical properties required by referenced ASTM standards.
2. Stone accessories and other manufactured products.

B. Certificate of origin for submitted materials.

C. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

D. Installer Certificates: Signed by product manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install his products.

E. Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer’s representative.

F. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.

G. Grout Samples for Initial Selection: For each type of grout indicated.

H. Samples for Verification:

1. For each stone type indicated, in sets of Samples not less than 600 x 600 mm. Include two or more Samples in each set and show the full range of variations in appearance characteristics expected in completed Work.

2. For each color of grout required.

I. Qualification Data: For Installer and fabricator.

J. Maintenance Data: For stone flooring to include in maintenance manuals. Include Product Data for stone-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

K. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An installer who employs experienced mechanics and stone fitters who are skilled in installing stone flooring similar in material, design, and extent to those indicated for this Project and whose projects have a record of minimum three years documented experience of successful in-service performance.

B. Fabricator Qualifications: Shop that employs skilled workers who fabricate stone flooring similar to those indicated for this Project and whose products have a record of successful in-service performance.

C. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.

1. Obtain each variety of stone from a single quarry, whether specified in this Section or in another Section of the Specifications.

D. Source Limitations for Other Materials: Obtain each type of cementitious material, grout, admixture, stone accessory, sealant, and other material from a single manufacturer.

E. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.

1. Build mockups as directed by the Engineer.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by the Engineer in writing.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

B. Store stone on wood A-frames or pallets with nonstaining separators and nonstaining, waterproof covers. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.7 PROJECT CONDITIONS

A. Do not set stone when air or material temperature is below 10 deg C.

B. Maintain minimum ambient temperatures of 10 deg C during installation and for 7 days after completion unless higher temperatures are required by fabricator's or supplier's instructions.

C. Hot-Weather Requirements for Exterior Stone Flooring: Protect stone flooring when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 38 deg C and above.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard for materials and workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works

PART 2 - PRODUCTS

2.1 STONE, GENERALLY

A. Provide stone that is free of cracks, seams, and starts impairing structural integrity or function.

B. Provide stone from a single quarry for each variety of stone required.

1. For each stone variety, provide matched blocks extracted from contiguous locations in a single bed of quarry stratum unless the Engineer approves stone from blocks randomly selected for aesthetic effect.

C. Quarry stone in a manner to ensure that as-quarried block orientations yield finished stone with required characteristics.

D. For natural stones, make quarried blocks available for the Engineer to examine for appearance characteristics.

E. Make stone slabs available for the Engineer to examine for appearance characteristics.

1. Engineer will select aesthetically acceptable slabs and will indicate aesthetically unacceptable slabs and portions of slabs.

2. Segregate slabs selected for use on Project and mark backs indicating approval.

3. Mark and photograph aesthetically unacceptable portions of slabs as directed by the Engineer.

2.2 GRANITE

A. Granite: Comply with ASTM C 615.

1. Products: Subject to compliance with requirements and to the approval of the Engineer.
2. Granite shall have the following minimum physical properties:
   a. Absorption by weight: 0.4% max. as per ASTM C97.
   b. Density, min: 2,560 Kg/m³ as per ASTM C97.
   c. Modulus of Rupture, min.: 1,500psi (10.34 MPa) as per ASTM C99.
   d. Compressive strength, min: 19,000psi (131 MPa) as per ASTM C170.
   e. Abrasion Resistance, min: Ha=25.0 as per ASTM C241.
   f. Flexural Strength, min: 1,200psi (8.2 MPa) as per ASTM C880.
   g. Chemical Resistance: Unaffected, ISO 10545.13

B. Match Engineer's samples for color, finish, and other stone characteristics relating to aesthetic effects.

C. Thickness: Not less than 25mm unless otherwise indicated.

2.3 NATURAL STONE AND MARBLE

A. Marble: Comply with ASTM C 503:

1. Products: Subject to compliance with requirements, and to the approval of the Engineer.
2. Marble shall have the following minimum physical properties:
   a. Absorption by weight: 0.2% max as per ASTM C97.
   b. Density, min.: 2,600 Kg/m³ as per ASTM C97.
   c. Compressive strength, min.: 9000psi (62 MPa) as per ASTM C170.
   d. Modulus of Rupture, min.: 1,200 psi (8.2 MPa) as per ASTM C99.
   e. Flexural Strength, min.: 1,200 psi (8.2 MPa) as per ASTM C880.
   f. Coefficient of friction: 0.60 as per ASTM C 108-89.
   g. Chemical Resistance: Unaffected, ISO 10545.13
   h. Deep Abrasion Resistance: 125 mm3, ISO 10545.6

B. Types:

1. As selected by Engineer

C. Finish:

1. Marble: Polished, unless otherwise indicated.

D. Marble Thickness: Not less than 20mm unless otherwise indicated.

1. Color: as selected by Engineer.

E. Dimensions:

1. as shown on drawings and details

2.4 Carborundum strip: anti-slip strips, 20mm wide, should be placed flush in the tread surface near the nose as shown on Drawings

2.5 Marble Thresholds/jamb & Sill: Provide marble thresholds/Sill complying with ASTM C 503 requirements for exterior and interior use and with a minimum abrasive-hardness value of 10 per ASTM C 241.

1. Provide best quality of type as indicated on Drawings complying with ASTM C 615 requirements.

B. Dimensions:

1. as shown on drawings and details

2.6 PRECAST TERRAZZO FLOOR TILES AND BASE:

A. Terrazzo tiles shall be 600 mm x 600 mm x 20 mm, unless otherwise indicated on drawings. Terrazzo tiles shall consist of natural, sound, crushed marble chips without excessive flats or flakes, with colors as selected from manufacturer's range of colors. Chips shall be a mixture of sizes 6 mm (No. 1) - 10 mm (No. 2) of equal parts. Matrix shall be either white or colored cement. Marble chips shall have a dust content of less than 1% by weight and shall have an abrasion resistance of not less than HA10 in accordance with ASTM C241. The mix shall consist of 3 parts of marble chips to one part of cement by weight. The facing layer shall provide a minimum wearing thickness of 6 mm after grinding. Terrazzo bases (if required) shall be from the same mix, and shall be 100 x 20 mm thick, unless indicated otherwise on the drawings.

1.	Finish	:	Smooth
2.	Bulk density	:	Average of 1900 kg/m^3 (ASTM C-97)
3.	Compressive strength	:	68 MPa (ASTM C-170)
4.	Lateral strength	:	Transverse strength of 7.5 MPa.
5.	Total absorption	:	3.85% by weight (BS en 13748)
6.	Abrasion resistance	:	Average of 0.48 mm/after 1000 revolution
7.	Type of installation	:	Laid on cement-sand mortar (1:4) mix

2.7 DIVIDER STRIPS (Where Required):

A. Divider strips, where required, shall be of white alloy zinc or half-hard brass, angle or "T" type for adhesive bonding to substrate.

B. SEALER:Interior floor penetrating sealer shall be colorless, slip and stain resistance which will not affect color and physical properties of terrazzo surface.

2.8 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: do not use lime.

C. Portland Cement Mix: Packaged blend of portland cement complying with ASTM C 150, Type I, aggregate, water retaining and other suitable admixtures. Properties shall be as follows:

1. Wet mix life : <1.5 hours
2. Initial adhesion at 28 days : > 0.3 N/mm2
3. Bending (flexural) strength : not less than 1 N/mm2
4. Compressive strength : 5 ±1 N/ mm2
5. Minimum cement sand mix : 1:3-4
6. Test (Cylinder test) : ASTM C780

D. For pigmented mortar, use a colored portland cement mix as required to produce color indicated or, if not indicated, as selected from manufacturer's standard formulations.

1. Pigments shall be composed of natural or synthetic iron oxides, compounded for use in mortar mixes, and with a record of satisfactory performance in stone mortars.
2. Pigments shall not exceed 10 percent of portland cement by weight.

E. Aggregate: ASTM C 144, except for joints narrower than6 mmand pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve:

1. White Aggregates: Natural white sand or ground white stone.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.

F. Latex additive (water emulsion) described below, serving as replacement for part of or all gaging water, of type specifically recommended by latex-additive manufacturer for use with job-mixed portland cement mortar and not containing a retarder.

1. Latex Additive: Styrene-butadiene rubber.

G. Water: Potable.

2.9 GROUT

A. Grout Colors: As selected by the Engineer.

B. Sand-Portland Cement Grout: ANSI A108.10.

C. Standard Cement Grout: ANSI A118.6.

1. Unsanded grout mixture for joints 3 mm and narrower.

2.10 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.

B. Control-Joint System: 10mm PVC control joint, comply with requirements specified in Division 5, section “Architectural Joint Systems”.

C. Cleaner: Stone cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer and, if a sealer is specified, by sealer manufacturer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

D. Floor Sealer: Colorless, slip- and stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

E. Sealants: Comply with Division 7, Section “Joint Sealants”.

F. Abrasive Inserts for Stair Treads: Silicon carbide or aluminum oxide in epoxy-resin binder.

G. Stone Pedestals: Manufacturer’s standard styrene-butadiene rubber, HDPE, or polyurethane paver support assembly including adjustable or stackable pedestals, shims, and spacer tabs for joint spacing of 3mm or 5mm.

H. Carborundum strip: anti-slip strips, 20mm wide, should be placed flush in the tread surface near the nose as shown on Drawings.

2.11 STONE THRESHOLDS

A. General: Provide stone thresholds that are uniform in color and finish, fabricated to sizes and profiles indicated to provide transition between tile surfaces and adjoining finished floor surfaces.

1. Fabricate thresholds to heights indicated, but not more than 12.7 mm above adjoining finished floor surfaces, with transition edges beveled on a slope of no greater than 1:2.

B. Marble Thresholds: Provide marble thresholds complying with ASTM C 503 requirements for exterior use and with a minimum abrasive-hardness value of 10 per ASTM C 241.

1. Provide best quality of type as indicated on Drawings complying with ASTM C 615 requirements.

2.12 STONE FABRICATION

A. General: Fabricate stone flooring in sizes and shapes necessary to comply with requirements indicated, including details on Drawings and Shop Drawings.

1. For marble, comply with recommendations in MIA's "Dimensional Stone--Design Manual IV."
2. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
3. Fabricate stone thresholds in sizes and profiles as indicated or required to provide transition between adjacent floor finishes.

B. Cut stone to produce pieces of thickness, size, and shape indicated and to comply with fabrication and construction tolerances recommended by applicable stone association.

1. Thickness of Stone Flooring: As indicated on Drawings, but not less than thickness recommended by supplier of the stone.
2. Stone Edges: Square.
3. Clean sawed backs of stones to remove rust stains and iron particles.

C. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

D. Fabricate stone stair treads in sizes and profiles indicated. Rout grooves into treads to receive abrasive strips and install strips to comply with manufacturer's written directions.

E. Finish exposed faces and edges of stone to comply with requirements indicated for finish under each type of stone required and to match approved samples and mockups.

1. Polished Finish: Grind exposed surfaces and edges in the workshop to a high luster with reflection.
2. Honed Surface Finish: Grinding in the workshop to a low luster without reflections.
3. Thermal (Flamed) Surface Finish: Factory application of high temperature flames to spall the surface resulting in textured dull finish.

2.13 MORTAR AND GROUT MIXES

A. Mortar: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

1. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.
2. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Discard mortar when it has reached initial set.
3. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive stone. Minimum cement content shall be 30 kg per each cubic meter of sand. For latex-modified-Portland cement setting-bed mortar, substitute latex admixture for part or all of water according to latex additive manufacturer's written instructions.

C. Mortar Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.

D. Latex-Modified Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.

E. Joint Grout: Comply with mixing requirements of referenced ANSI standards and manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive stone flooring, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance.

1. For the record, prepare a written report, endorsed by Installer, listing conditions detrimental to performance of stone flooring.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Vacuum clean / Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

B. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION, GENERAL

A. Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight and true, with edges eased slightly to prevent snipping.

B. Set stone to comply with Drawings and Shop Drawings.

C. Scribe and field-cut stone as necessary to fit at obstructions. Produce tight and neat joints.

D. Expansion- and Control-Joint Installation: Locate and install according to Drawings and Shop Drawings. Joint-sealant materials and installation are specified in Division 7 Section "Joint Sealants."

3.4 INSTALLATION TOLERANCES

A. Variation in Line: For positions shown in plan for edges of flooring, steps, changes in color or finish, and continuous joint lines, do not exceed 3 mm in 3 m, 6 mm in 6 m, or 10 mm maximum.

B. Variation in Joint Width: Do not vary joint thickness more than 1.5 mm or 1/4 of nominal joint width, whichever is less.

C. Variation in Surface Plane of Flooring: Do not exceed 3 mm in 3 m, 6 mm in 6 m, or 10 mm maximum from level or slope indicated.

D. Variation in Plane between Adjacent Units (Lipping): Do not exceed 0.8-mm difference between planes of adjacent units.

3.5 INSTALLATION OF STONE DIRECTLY OVER CONCRETE

A. Saturate concrete with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar bed bond coat to damp concrete and broom to provide an even coating that completely covers the concrete. Do not exceed 1.5-mm thickness. Limit area of mortar bed bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed immediately after applying mortar-bed bond coat. Spread, tamp, and screed to uniform thickness at elevations required for setting stone to finished elevations indicated. For setting beds exceeding 35 mm in depth, use one layer of wire reinforcement as specified located at mid depth.

D. Mix and place only that amount of mortar bed that can be covered with stone before initial set. Cut back, bevel edge, and discard material that has reached initial set before stone can be placed.

E. Place stone before initial set of mortar occurs. Immediately before placing stone on setting bed, apply uniform 1.5-mm- thick bond coat to bed or to back of each stone unit.

F. Tamp and beat stone with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each unit in a single operation before initial set of mortar; do not return to areas already set and disturb stone for purposes of realigning finished surfaces or adjusting joints.

G. Point joints after setting. Fill full with mortar type and color indicated. Tool joints flat, uniform, and smooth, without visible voids.

H. Rake out joints to depth required to receive grout as units are set.

3.6 INSTALLATION OF STONE DIRECTLY OVER CONCRETE OR SCREED

A. After the concreting is finished the concrete or screed must be moistened properly and protected against too quick evaporation or against frost for at least 15 days.

B. The humidity of the concrete must be max. 2 – 3% before the installation. The humidity is measured by a carbide moisture meter.

C. Minimum compressive strength of the concrete must be to 22 MPa.

D. The strength in tension of the subfloor (the strength of the surface layer) of the concrete must be at least 0.8 MPa.

E. In case of an uneven surface it is necessary to perform leveling or correction by using suitable leveling materials. Deviation from the flatness should be maximum ±2 mm on 2 m of the surface.

F. Apply bonding primer to the subfloor (from Mapei, or approved equal).

G. To mix the agents of adhesive, use a mechanical mixer with small number of revolutions.

H. The prepared adhesive should be well rubbed as a thin layer to the base to build a quality transition between the base, the adhesive and the tile.

I. . Afterwards the layer of the adhesive should be spread on the base.

J. A continuous 1mm layer of the adhesive should be applied on the bottom face of the tile and the tile should be glued to the tooth-formed adhesive applied to the base.

K. The tiles should be installed by keeping the joint from 3 up to 7 mm according to the characteristics of the base, the sizes, dimensional stability and thermal expansion coefficient of the product and according to the environment, where the installation takes place.

3.7 STONE THRESHOLD INSTALLATION

A. At locations adjacent to stone flooring, install stone thresholds in same type of setting bed as abutting stone paving and flooring, unless otherwise indicated.

1. Set thresholds in thin-set, latex-portland cement mortar to comply with ANSI A108.5 at locations where mortar bed would otherwise be exposed above other adjacent paving and flooring.

B. At locations not adjacent to stone flooring, install stone thresholds in full bed of water-cleanable epoxy adhesive to comply with ANSI A108.4.

3.8 GROUTING OF STONE FLOORING

A. Grout stone joints to comply with ANSI A108.10 and manufacturer's written instructions.

1. Do not use sanded grout for polished stone.

B. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining stone and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free of drying cracks.

C. Cure grout by maintaining in a damp condition for seven days except as otherwise recommended by latex-additive manufacturer.

3.9 ADJUSTING AND CLEANING

A. Remove and replace stone flooring of the following description:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by the Engineer.
2. Defective joints.
3. Stone flooring, and joints not matching approved samples and mockups.
4. Stone flooring not complying with other requirements indicated.

B. Replace in a manner that results in stone flooring's matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone flooring as work progresses. Remove mortar fins and smears before tooling joints.

D. Clean stone flooring after setting and grouting are complete. Use procedures recommended by stone fabricator for types of application.

E. Apply sealer to cleaned stone flooring according to sealer manufacturer's written instructions.

3.10 PROTECTION

A. Prohibit traffic from installed stone for a minimum of 72 hours.

B. Protect stone flooring during construction with nonstaining kraft paper. Where adjoining areas require construction work access, cover and flooring with a minimum of 20-mm untreated plywood over nonstaining kraft paper.

SECTION 096900 - ACCESS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Floor panel coverings.

1.3 DEFINITION

A. ESD: Electrostatic discharge. The transfer of electric charge between bodies at different potentials.

1.4 SYSTEM DESCRIPTION

A. Access Flooring System: Assemblies composed of modular floor panels on pedestals with stringers.

1.5 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide access flooring systems capable of withstanding the following loads and stresses within limits and under conditions indicated, as determined by testing manufacturer's current standard products according to referenced procedures in CISCA A/F, "Recommended Test Procedures for Access Floors":

1. Concentrated Loads: Provide floor panels, including those with cutouts, capable of withstanding a concentrated design load of 4.5KN, with a top-surface deflection under load and a permanent set not to exceed, respectively 2.5mm and 0.25 mm according to CISCA A/F, Section I, "Concentrated Loads."
2. Uniform Loads: Provide floor panels, including those with cutouts, capable of withstanding a uniform design load of 2500kg/m², with a top-surface deflection under load and a permanent set not to exceed, respectively, 2.5mm and 0.25 mm.
3. Safety Factor: Panel supported on actual understructure (the system) shall be capable of withstanding a minimum of (2) two times the design load anywhere on the panel without failure. Failure is defined as the point at which the system will no longer accept the load
4. Support Structure Performance: The structure shall tolerate a vertical axial load 4 times heavier than the values of concentrated loads, for five minutes without showing any structural settling.

B. ESD-Control Properties: Provide floor coverings with ESD-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.

1. Antistatic Floor Covering Properties:

a. Electrical Resistance: Test per ESD STM 7.1.

1) Average greater than 25,000 ohms and less than 1,000 megohm when test specimens and installed floor coverings are tested surface to surface (point to point).

C. Fire Resistance: Value = 60 (REI index).

1.6 SUBMITTALS

A. Design: Submit design, calculation and dates of to sustain all live and dead loads imposed on the deck.

B. Product Data: For each type of product indicated.

C. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

D. Shop Drawings: Include layout of access flooring system and relationship to adjoining Work based on field-verified dimensions.

1. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructure.
2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Samples for Initial Selection: For each type of flooring material and exposed finish indicated.

F. Samples for Verification: For each type of flooring material and exposed finish indicated.

1. One complete full-size floor panel, pedestal, and understructure unit for each type of access flooring system required.

G. Product Certificates: For each type of access flooring system, signed by product manufacturer.

H. Qualification Data: For Installer.

I. Fire-retrained Treatment: Include certification by treating plant, show that treatment materials comply with governing regulation.

J. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, or performed by access flooring manufacturer and witnessed by a qualified testing agency, for each type of flooring material and exposed finish.

K. Catalogue: Submit catalogue specifying all materials that enter in the description.

L. Manufacturer's installation instructions and guidelines.

M. Manufacturer's Owner Manual outlining recommended care and maintenance procedures.

N. Warranty: The contractor shall guarantee the materials, products and installation to be sound and free from all defects for a period of minimum 10 years from date of completion and acceptance of the work.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain access flooring system through one source from a single manufacturer.

C. Regulatory Requirements: Fabricate and install access flooring to comply with NFPA 75 requirements for raised flooring.

D. Provide floor panels that are clearly and permanently marked on their underside with panel type and concentrated-load rating. and fabricated by a manufacturing facility that has demonstrated a successful 10-year track record of local installations ofsimilar size and complexityMockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical access flooring assembly as shown on Drawing. Size to be an area no less than five floor panels in length by five floor panels in width.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
3. Review connection with mechanical and electrical systems.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install access flooring until spaces are enclosed, subfloor has been sealed, ambient temperature is between 4 and 32 deg C, and relative humidity is not more than 70 percent.

1.9 COORDINATION

A. Coordinate location of mechanical and electrical work in underfloor cavity to prevent interference with access flooring pedestals.

B. Mark pedestal locations on subfloor by use of a grid to enable mechanical and electrical work to proceed without interfering with access flooring pedestals.

C. Proceed with installation only after completion of other construction within affected spaces.

PART 2 - PRODUCTS

2.1 FLOOR PANELS AND UNDERSTRUCTURE

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work.

B. Floor Panels, General: Provide modular panels complying with the following requirements that one person, using a portable lifting device, can interchange with other field panels without disturbing adjacent panels or understructure:

1. Nominal Panel Size: 800 by 800 mm.
2. Fabrication Tolerances: Fabricate panels to the following tolerances with squareness tolerances expressed as the difference between diagonal measurements from corner to corner:
    a. Size and Squareness: Plus or minus 0.38 mm of required size, with a squareness tolerance of plus or minus 0.38 mm, unless tolerances are otherwise indicated for a specific panel type.
    b. Flatness: Plus or minus 0.50 mm, measured on a diagonal on top of panel.

C. Panel Componenets:

1. Compressed straw building slabs shall comply with BS 4046.
2. Specification for wood clipboard shall comply with BS EN 312
3. Specification for block board and lamina board shall comply with BS 3444.
4. Floor Panels: Shall consist of high density chipboard of 700 kg/m3 density.
5. Perimeter protection: Self-extinguishing PVC.
6. Bottom coverings: 0.05mm thick aluminum film.
7. Upper coverings: Vinyl layer unless otherwise indicated.

D. Pedestals:

1. Hot rolled steel sheets and strip: Commercial quality carbon steel, complying with BS EN 10162.
2. Hot dip galvanized steel sheet and coil: Shall conform to BS EN 10143.
3. Pedestal assemblies shall be corrosive resistant, all steel welded construction, and shall provide an adjustment range.
4. Pedestal assemblies shall provide a means of leveling and locking the assembly at a selected height, which requires deliberate action to change height setting and prevents vibration displacement.
5. Galvanized steel pedestal head shall be welded to a threaded rod which includes a specially designed adjusting nut. The nut shall provide location lugs to engage the pedestal base assembly, such that deliberate action is required to change the height setting.
6. Threaded rod shall provide a specially designed anti-rotation device, such that when the head assembly is engaged in the base assembly, the head cannot freely rotate.
7. Galvanized pedestal base assembly shall consist of a formed steel welded to a square steel tube and shall be designed to engage the head assembly.

E. Stringers

1. Hot dip galvanized stringers shall support each edge of panel type should be as shown on Drawings and as per manufacturer’s requirements.

F. Aluminium

1. Aluminum and aluminum sections shall comply with BS EN 485.

2.2 FLOOR PANEL COVERINGS

A. General: Provide factory-applied vinyl floor coverings of type indicated that are laminated by access flooring manufacturer to tops of floor panels.

B. Colors, Textures, and Patterns: As selected by Engineer from manufacturer's full range.

C. Edging: Manufacturer's standard integral edge trim. Provide size and profile of applied edge trim that fits floor coverings selected.

2.3 ACCESSORIES

A. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer and manufacturer's representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, foreign deposits, and debris that might interfere with attachment of pedestals.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preinstallation Adhesive Field Test: Before installing pedestals, field test their adhesion to subfloor surfaces as follows:

1. In areas representative of each subfloor surface, set typical pedestal assemblies in same adhesive and methods required for completed work.
2. Allow test installation to cure for 30 days, with a pressure of 111 N applied vertically to pedestals during this period.
3. After curing, apply lateral load against a straight steel bar inserted 51 mm into pedestal stems. Measure the force needed to cause adhesive failure of pedestal base.
4. Proceed with installation only after tests show compliance with performance requirement specified for pedestals' capability to resist overturning moment.

3.2 PREPARATION

A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 152 mm.

B. Locate each pedestal, complete any necessary subfloor preparation, and vacuum clean subfloor to remove dust, dirt, and construction debris before beginning installation.

3.3 INSTALLATION

A. Install access flooring system and accessories under supervision of access flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.

B. Set pedestals in adhesive as recommended in writing by access flooring manufacturer to provide full bearing of pedestal base on subfloor.

C. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.

D. Secure stringers to pedestal heads according to access flooring manufacturer's written instructions.

E. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.

F. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 3 mm where panels abut vertical surfaces.

1. To prevent dusting, seal cut edges of steel-encapsulated, wood-core panels with sealer recommended in writing by panel manufacturer.

G. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under access flooring already installed.

H. Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.

I. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area, as installation of floor panels proceeds.

J. Install access flooring without change in elevation between adjacent panels and within the following tolerances:

1. Plus or minus 1.5 mm in any 3-m distance.
2. Plus or minus 3 mm from a level plane over entire access flooring area.

K. Vinyl Skirting shall be installed at perimeters.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Prohibit traffic on access flooring for 24 hours and removal of floor panels for 72 hours after installation to allow pedestal adhesive to set.

B. After completing installation, vacuum clean access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until time of Substantial Completion.

C. Replace access flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes surface preparation and field painting of exposed interior items and surfaces.

B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, the Engineer will select from standard colors and finishes available.

C. All paint shall be anti-bacterial and hygiene.

D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:
   a. Architectural woodwork.
   b. Toilet enclosures.
   c. Finished mechanical and electrical equipment.
   d. Light fixtures.
   e. Elevator entrance doors and frames.
2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
   a. Furred areas.
   b. Ceiling plenums.
   c. Utility tunnels.
   d. Pipe spaces.
   e. Duct shafts.
3. Finished metal surfaces include the following:
   a. Anodized aluminum.
   b. Stainless steel.
   c. Chromium plate.
   d. Copper and copper alloys.
   e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:
   a. Valve and damper operators.
   b. Linkages.
   c. Sensing devices.
   d. Motor and fan shafts.
5. Labels: Do not paint over labels or equipment name, identification, performance rating, or nomenclature plates.

E. Related Sections include the following:
1. Division 9 Section "Portland Cement Plaster".
2. Division 9 Section "Gypsum Board".
3. Division 9 Section " Architectural wood works"
4. Division 8 Section "Wood doors"
5. Division 9 Section "High-Performance Coatings".
6. Refer to the finishing schedule for locations of application.

1.3 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.
1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

C. Comparable Product Requests: Submit three copies of each request for consideration. Identify product to be replaced. Include a detailed comparison of physical properties, qualities and performance characteristics between specified and proposed comparable paint product, including as a minimum:

1. Chemical composition and properties.
2. Opacity.
3. Cleanability.
4. Scrub resistance, wet and dry
5. Adhesion.
6. Exposure resistance.

D. Samples for Initial Selection: For each type of finish-coat material indicated.
   1. After color selection, Contractor shall furnish color chips for surfaces to be coated.

E. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
   1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
   2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
   3. Submit 3 Samples on the following substrates for Engineer's review of color and texture only:
      a. Concrete / Masonry: 100-by-150-mm Samples for each color and finish.
      b. Painted Wood: 200-mm- square Samples for each color and material on hardboard.
      c. Stained or Natural Wood: 100-by-200-mm Samples of natural- or stained-wood finish on representative surfaces.

F. Qualification Data: For Applicator.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain fillers and primers for each coating system from the same manufacturer as the finish coats.

C. Performance Of Paints: Paints shall be fit for purpose and manufactured specifically for the applications indicated and uses intended, taking into account the type, nature, location, and aesthetic and utility requirements of the project
   1. Opacity: paint shall cover or hide the substrate to the Engineer's satisfaction.
   2. Cleanability: paint shall not absorb dirt and shall be capable of being washed or scrubbed periodically, to the Engineer's satisfaction, without adverse effect on its attributes or appearance.
   3. Scrub resistance wet and dry: paint shall resist abrasion caused by scrubbing in accordance with ASTM D 2486.
   4. Adhesion: paint shall adhere firmly to the substrate without peeling.

D. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required.

1. Engineer will select one room or surface to represent surfaces and conditions for application of each type of coating and substrate.

a. Wall Surfaces: Provide samples on at least 9 sq. m.

b. Small Areas and Items: Engineer will designate items or areas required.

2. Apply benchmark samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, color, and texture on each surface.

a. After finishes are accepted, Engineer will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from benchmark samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7 deg C. Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.7 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 10 and 32 deg C.

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 7 and 35 deg C.

C. Do not apply paint in rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 3 deg C above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 WARRANTY

A. Special Warranty for Painting works: The Contractor shall provide a guarantee of material and workmanship for all painting works provided under this Contract.

1. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Manufacturers' Names:

1. Jotun
2. Sipes
3. Tinol
4. Colortek
5. DULUX
6. Or approved equal

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: As selected by the Engineer from manufacturer's full range.

D. Paint shall be anti-bacterial and hygiene as per manufacturer requirement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Engineer about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer’s written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.

2. Concrete, External Portland Cement Plaster and Concrete Masonry. Prepare concrete and concrete masonry blocks, surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.

b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.

c. For concrete surfaces and external plaster apply a priming coat and fill blow holes, minor cracks and other surface defects with compatible stucco and rub down flush with surface.

d. For concrete masonry surfaces, fill holes, cracks and other surfaces defects with block filler flush with surface and apply one coat of the filler to fully cover paint area.

3. Internal Portland Cement Plaster:

a. Clean the surface and remove efflorescence, chalk, dust, dirt, grease or oils.

Smooth the surface with sand papers or abrasive papers and remove trowel marks if any. Clean the surface and apply a priming coat. Apply two coats of compatible stucco in both directions, vertical and horizontal and sand as required to obtain perfect smooth uniform surfaces. Use putty/block filler where required or directed by the Engineer.

4. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

   a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.

   b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and paneling.

   c. If transparent finish is required, backprime with spar varnish.

   d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on back side.

   e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.

2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

3. Provide finish coats that are compatible with primers used.

4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.

5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
9. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges and corners receive a dry film thickness equivalent to that of flat surfaces.
3. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Block Fillers: Apply block fillers to concrete and concrete masonry block at a rate to ensure complete coverage with pores filled.

F. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

G. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting,

holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

H. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.

1. Provide satin finish for final coats.

I. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

J. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 FIELD QUALITY CONTROL

A. Engineer reserves the right to invoke the following test procedure at any time and as often as Employer deems necessary during the period when paint is being applied:

1. Engineer will engage a qualified independent testing agency to sample paint material being used. Samples of material delivered to Project will be taken, identified, sealed, and certified in the presence of Contractor.

2. Testing agency will perform appropriate tests for the compliance with product requirements.

3. Engineer may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the noncomplying paint. If necessary, Contractor may be required to remove noncomplying paint from previously painted surfaces if, on repainting with specified paint, the two coatings are incompatible.

3.5 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.6 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Engineer.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces.

3.7 PARTICULAR SPECIFICATIONS

A. WALL PUTTY

1. Surfaces where indicated shall receive one or more applications of putty filler until smooth surface is obtained to the Engineer's approval.

B. ACRYLIC PAINT

1. Provide, store and apply anti-bacterialacrylic paint to substrates with the following requirements complementary to the general specifications including all needed materials, accessories, tools and scaffolding.
2. Acrylic based semi-gloss finish to be wed in water solvent paint systems applied on interior columns, walls and ceilings.

Colour	:	To the selection of the Engineer
Finish	:	Flat, unless otherwise specified
Recommended thinner	:	Sweet water
Description	:	High quality acrylic latex paint, 100% acrylic latex resin, durable, mildew resistant, alkaline resistant. Semi-gloss water borne thixotropic paint based on a pure acrylic emulsion.
Mass density	:	Approx. 1.36 g/cm³
Solid contents	:	Approx. 40 % by volume depending on colours
Over coating intervals	:	min. 3 hours
Flash point	:	None
Shelf time	:	Over 1 year
Type of application	:	Synthetic brush or medium nap roller
Primer	:	As per Manufacturer recommendations
Number of coats	:	As per Manufacturer's recommendations and to the satisfaction of the Engineer
Plastered walls and ceilings	:	Cleaning - Primer - Putty - Sanding - Undercoat - Putty - Sanding - Paint - Checking - Paint.
Masonry Concrete	:	Cleaning - Masonry filler - Sanding - Undercoat - Putty - Sanding - Paint - Paint, unless otherwise recommended by the Manufacturer.

Note: Use putty wherever required by the Engineer.

3. Concrete: Provide the following paint systems over cementitious surfaces:
   a. Flat Acrylic Finish: primer + undercoat + 2 finish coats.
   b. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.025mm.
   c. Undercoat: same material for finish coats specified hereafter diluted to the manufacturer's recommendations.
   d. First and Second Coats: Flat, acrylic latex-based, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.060mm per coat.

4. Gypsum Board: Provide the following finish system over interior gypsum board surfaces:
   a. Flat Acrylic Finish: primer + undercoat + 2 finish coats.
   b. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031mm.
   c. First and Second Coats: Flat, acrylic-latex-based, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.060mm.
5. Plaster: Provide the following finish systems over new, interior Portland cement plaster surfaces:
   a. Flat Acrylic Finish: primer + undercoat + 2 finish coats.
   b. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.036mm.
   c. Undercoat: same material for finish coats specified hereafter diluted to the manufacturer's recommendations.
   d. First and Second Finish Coats: Flat, acrylic-latex, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.064mm per coat.

C. Woodwork and Hardboard: Provide the following paint finish system over new, interior wood surfaces:
1. Semigloss Acrylic-Enamel Finish: 2 finish coats over a wood undercoat.
   a. Undercoat: Alkyd- or acrylic-latex-based, interior wood undercoater, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031mm.
   b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.066mm.
2. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a wood undercoater.
   a. Undercoat: Alkyd, interior enamel undercoater applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031mm.
   b. First and Second Coats: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.061mm.

D. Stained Woodwork: Provide the following stained finishes over new, interior woodwork:
1. Alkyd-Based, Satin-Varnish Finish: 2 finish coats of an alkyd-based, clear-satin varnish over a sealer coat and an alkyd-based, interior wood stain. Wipe wood filler before applying stain.
   a. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.
   b. Stain Coat: Alkyd-based, interior wood stain applied at spreading rate recommended by the manufacturer.

c. Sealer Coat: Clear sanding sealer applied at spreading rate recommended by the manufacturer.

d. First and Second Finish Coats: Alkyd-based or polyurethane varnish, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.

E. Natural-Finish Woodwork: Provide the following natural finishes over new, interior woodwork:

1. Polyurethane, Satin-Varnish Finish: 2 finish coats of a polyurethane, clear-satin varnish over a sanding sealer. Provide wood filler on open-grain wood before applying first varnish coat.

a. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

b. Sealer Coat: Clear sanding sealer applied at spreading rate recommended by the manufacturer.

c. First and Second Finish Coats: Polyurethane varnish, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.

F. EMULSION PAINT

1. Provide, store and apply anti-bacterial emulsion paint to substrates with the following requirements complementary to the general specifications including all needed materials, accessories, tools and scaffolding.

2. Emulsion paint, to be used in water solvent paint systems applied.

Colors and finishes	:	To the selection of the Engineer
Description	:	High quality acrylic copolymer based emulsion paint. Alkaline resistant and washable.
Mass density	:	Approx. 1.3 g/cm³,
Solid contents	:	39 % by weight , depending on colors
Over coating intervals	:	min. 2 hours
Clean-up solvent	:	Soap & water
Type of application	:	Spray, brush or roller
Number of coats	:	To the satisfaction of the Engineer and the following minimum application Primer + 2 coats putty + undercoat + 2 finish coats

G. ANTI-DUST PAINT TO WALLS

1. Provide, store and apply anti-bacterial; anti-dust paint to the substrates with the following requirements, with all needed materials, accessories, tools and scaffolding.

Color	:	to the selection of the Engineer
Finish		Satin finish, unless otherwise specified
Description	:	Modified acrylic resin, alkali resistant for concrete surfaces, unless otherwise recommended by the Manufacturer. Silicone resin for masonry surfaces, unless otherwise recommended by the Manufacturer. PART 4 - Excellent abrasion and scuff resistance. Prevents dusting and oil absorption.
Density	:	Approx. 1.36 g/cm³
Over coating intervals	:	min.4 hours

Type of application	:	Roller
Total thickness of paint	:	As per manufacturer recommendation
Primer	:	As per Manufacturer recommendations
Number of coats	:	To the satisfaction of the Engineer and with the following minimum applications: Cleaning - Primer - Paint - Paint.

D. Natural-Finish Woodwork: Provide the following natural finishes over new, interior woodwork:

1. Polyurethane, Satin-Varnish Finish: 2 finish coats of a polyurethane, clear-satin varnish over a sanding sealer. Provide wood filler on open-grain wood before applying first varnish coat.

   d. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

   e. Sealer Coat: Clear sanding sealer applied at spreading rate recommended by the manufacturer.

   f. First and Second Finish Coats: Polyurethane varnish, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.

E. Opaque Finish Woodwork: Provide the following opaque finishes over new, interior woodwork:

1. Polyurethane Finish: 2 finish coats of a polyurethane over a sanding sealer. Provide wood filler on open-grain wood before applying first coat.

   a. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

   b. Sealer Coat: sanding sealer applied at spreading rate recommended by the manufacturer.

   c. First and Second Finish Coats: Polyurethane paint, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.

F. Stained Woodwork: Provide the following stained finishes over new, interior woodwork:

1. Alkyd-Based, Satin-Varnish Finish: 2 finish coats of an alkyd-based, clear-satin varnish over a sealer coat and an alkyd-based, interior wood stain. Wipe wood filler before applying stain.

   e. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

   f. Stain Coat: Alkyd-based, interior wood stain applied at spreading rate recommended by the manufacturer.

   g. Sealer Coat: Clear sanding sealer applied at spreading rate recommended by the manufacturer.

   h. First and Second Finish Coats: Alkyd-based or polyurethane varnish, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.

G. Where wood work should be protected against bacteria, fungi, yeasts and algae, a bactericide solution shall be added to the wood coating.

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes surface preparation and field application of epoxy high-performance coating systems floors and walls

1. Application of epoxy coating to walls and floors.
2. Application of road marking lines, road signs, hatches, and the like.
3. Application of Scratched Paint, elastic acrylic paint to external walls facades unless otherwise indicated.
4. Refer to the finishing schedule for locations of application.

B. It also includes High performance coating systems to steel elements as follows:

1. System 1: Anti-corrosion paint with polyurethane top coat.
   a. Zinc rich epoxy primer coat 75 microns
   b. Zinc rich epoxy intermediate coat 175 microns
   c. Aliphatic Polyurethane top coat 100 microns
2. System 2: Anti-corrosion paint with polyester powder coat.
   a. Zinc rich epoxy primer coat 75 microns
   b. Zinc rich epoxy intermediate coat 175 microns
   c. Polyester Powder coating top coat of minimum dry film thicknesses 80 microns.
3. System 3: Anti-corrosive and intumescent Coating system to have Fire rating period as indicated on Drawings.
   a. Apply one coat (2 component Zinc rich epoxy primer) @ 75 microns dry film thickness.
   b. After curing, apply (single pack thin film intumescent coatings) dry film thickness is to be as per approved submitted loading table for each section to be fire rated.
   c. After curing, apply (2 components Alyphatic polyurethane) @ 50 microns dry film thickness.

C. Related Sections include the following:

1. Division 5 Section “Metal fabrications”
2. Division 5 Section “Structural Steel Framing”
3. Division 9 Section "Interior Painting".

4. Division 9 Section “Portland Cement Plaster”.

1.3 DEFINITIONS

A. Standard coating terms defined in ASTM D 16 apply to this Section.

B. Gloss ranges used in this Section include the following:

1. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
2. High gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Submit name and address of proposed manufacturers, with dated reference to work of similar nature carried out on other project.

B. Product Data: For each coating system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified.

C. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

D. The manufacturer shall provide a certificate of compliance. The certificate shall certify that the paint material complies with the specifications.

E. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.

F. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1. After color selection, Contractor shall furnish color chips for surfaces to be coated.

G. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped Samples defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. List of material and application for each coat of each sample. Label each sample for location and application.
3. Submit samples on the following substrates for Engineer's review of color and texture:
   a. Concrete/Masonry: Provide two 100-mm- square samples for each color and finish.

b. Ferrous Metal: 100-mm- square Samples of flat metal and 200-mm- long Samples of solid metal for each color and finish

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and Employers, and other information specified.

I. Submit program and planning for work to be done on site.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

B. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

C. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

E. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample of each type of coating and substrate required.

1. Engineer will select one room, area, or surface to represent surfaces and conditions for application of each type of coating and substrate.
   a. Wall Surfaces: Provide samples on at least 9 sq. m of wall surface.
   b. Small Areas and Items: Engineer will designate items or areas required.
2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface as specified. Provide the required sheen, color, and texture of each surface.
   a. After finishes are accepted, Engineer will use the room or surface to evaluate coating systems of a similar nature.
3. Final approval of colors will be from benchmark samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.

7. Color name and number.
8. VOC content.
9. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7 deg C. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

1.7 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 7 and 35 deg C.

B. Do not apply coatings in rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 3 deg C above the dew point; or to damp or wet surfaces.

1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

1.8 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive Employer of other rights Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1. Special Warranty: Submit a written warranty, executed by the manufacturer, agreeing to repair or replace coatings that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Ten years for high performance coating from date of Taking Over Certificate of the whole of the Works.

C. High performance coating system shall be guaranteed against, but not limited to the following:

1. Adhesive or cohesive failures;
2. Abrasion or tearing failure;
3. Surface crazing;
4. Intrusion of water;
5. Discoloration as a result of UV attack.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements as indicated below and to the approval of the Engineer.

B. Approved Manufacturers:

C. Coating to steel: Ameron, DULUX, or approved equal

D. Coating to Concrete/ Masonry: Tremco, Flowcrete, Tinol, Colortek or approved equal

2.2 COATINGS MATERIALS, GENERAL

A. Provide best quality grade of various types of paints as regularly manufactured by acceptable paint manufacturers. Use only materials displaying manufacturer’s identification as a standard, best-grade product.

1. Proprietary names used to designate colours or materials are not intended to imply that products of named manufacturers are required to exclusion of equivalent products of other manufacturers

B. Federal Specifications, British standards, ASTM standards and AASHTO standards establish minimum acceptable quality for paint materials. Provide a written certification from manufacturer that materials provided meet or exceed these minimums.

C. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

D. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

E. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 450 g/L or less.

F. The Contractor shall coordinate with the works of other trades in order to set the common arrangements and procedures needed for the proper performance of the work. The Contractor should acquire all documents, specifications and drawings related to the other trades. The Contractor has to be aware of these documents, and cannot, in any case, ignore their contents

G. The Contractor shall sequence, coordinate and integrate the various elements of paint systems.

H. The Contractor shall coordinate material installation with other building components.

I. The Contractor shall verify dimensions by field measurements.

J. Paint and related materials shall be of a single manufacturer.

K. Anti-Carbonation Coating Performance: To confer long term protective and decorative properties to concrete and masonry surfaces. Micro-porous structure of the coating should act as a barrier to the ingress of Chlorides and Carbon Dioxide and other acid gases, but allows the passage of water vapor from the substrate. Elastomeric nature anti-carbonation coating ensures a good crack bridging properties in case of structural movement.

L. The work shall include block fillers and putty of layers and thicknesses as required by the engineer. The Block filler and putty must be compatible with the complete painting system in a manner required by the engineer.

M. Pavement Markings: Material used for all traffic stripes and markings shall be reflectorizing thermoplastic type complying with the requirements of AASHTO 249 and MOC Standards. Marking materials shall comprise of synthetic hydrocarbon thermoplastic resins, plasticizer, extenders, pigments, aggregate, and pre-mixed reflectorizing glass beads; and shall have surface applied glass beads to marking material at the time it is applied to the pavement.

2.3 COLORS

A. Colors: As selected by Engineer from manufacturer's full range.

2.4 POLYURETHANE COATING SYSTEMS

A. Provide the following painting systems over concrete floor surfaces suitable for pedestrian and vehicular traffic:

1. Provide a complete high performance, abrasion resistant, chemically resistant and flexible liquid applied polyurethane coating system having the following characteristics:
    a. Medium Duty applications: consist of 25 mil (DFT) basecoat and a 12 mil (DFT) topcoat.
    b. Heavy Duty applications: consist of 25 mil (DFT) basecoat and two 12 mil (DFT) topcoats.
    c. Vehicular Heavy Duty applications at ramps and where indicated on Drawings: consist of 25 mil (DFT) basecoat and two 12 mil (DFT) topcoats with silica sand.
    d. Vehicular Heavy Duty applications for road marking lines, road signs, hatches, and the like: consist of two 3 mil (DFT) reflective coats. All marking lines shall be sprayed with thermoplastic reflective paint or with glass beads over wet paint.
    e. System to comply with C 957-91 having a class A fire rating on concrete substrates according to UL 790.
    f. Polyurethane topcoat to have a tensile strength of 4000Psi and 100% elongation to ASTM D 412.
    g. Color to be selected by the Engineer from manufacturer’s standard color range.
    h. Recommended Manufacturer: TREMCO or approved equal.
2. Accessories:
    a. Primer: As recommended by coating system manufacturer.

b. Joint Backing: Closed-cell, polyethylene rod as recommended by coating manufacturer.

c. Silica sand: 1.0-1.2mm size silica sand; approved by coating manufacturer.

2.5 ANTI-CARBONATION COATING SYSTEMS

A. Coating Type: Acrylic Latex anti-corrosive, anti-carbonation; Low permeability to carbon dioxide and water. High permeability to water vapor.

B. Number of coats: minimum two coats, unless otherwise specified.

C. Color: to the selection of the engineer.

D. Application: Apply by brush to a wet film thickness of 175 microns to achieve a dry film thickness of 70 microns per coat.

E. Substrates: Plaster, fairface masonry, masonry, fairface concrete

2.6 EPOXY COATING SYSTEMS

A. Concrete and Masonry Walls: Provide the following painting system:

1. Provide complete multi-coat systems formulated and recommended by the manufacturer for the applications indicated, in the thicknesses indicated.
2. Epoxy coating to walls and columns shall be dry film thickness 350 micron comprising solvent base clear epoxy sealer primer 50 micron, basecoat 150 micron and topcoat 150 micron.
3. Colours shall be to the approval of the Engineer from manufacturer’s standard color range.
4. Finish: Semi-gloss unless otherwise specified.
5. Primer: As recommended by coating system manufacturer.
6. Joint Backing: Closed-cell, polyethylene rod as recommended by coating manufacturer.
7. Recommended Manufacturer: TREMCO, FLOWCRETE, or approved equal.

B. Concrete floors: Provide the following painting system:

1. Provide complete multi-coat systems formulated and recommended by the manufacturer for the applications indicated, in the thicknesses indicated.
2. Epoxy coating to floors shall be dry film thickness 400 micron comprising solvent free clear epoxy sealer primer 100 micron, and solvent free topcoat 300 micron.
3. Colours shall be to the approval of the Engineer from manufacturer’s standard color range.
4. Finish: Semi-gloss unless otherwise specified.
5. Primer: As recommended by coating system manufacturer.
6. Joint Backing: Closed-cell, polyethylene rod as recommended by coating manufacturer.
7. Aggregate, where required:

a. 40-50 mesh silica sand;

b. Aggregate shall be approved by coating manufacturer.

c. Two silica sand layers shall be applied at ramps.

d. Sieve analysis, based on ASTM C136, shall be submitted for approval.

8. Recommended Manufacturer: TREMCO, FLOWCRETE, or approved equal.

2.7 COATING SYSTEMS TO STEEL - GENERAL

A. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.

1. Blast steel surfaces clean as recommended by paint system manufacturer.

2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.

B. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods in addition to the acid etching application.

C. Exposed Steel:

1. Pre treatment: In case of oil or grease contamination, solvent cleaning according to SSPC -SP - 1 using detergent or emulsion cleaners (oil remover) or approved equivalent followed by high pressure fresh water washing to remove all residues and to insure oil or grease free areas. The Contractor shall repeat procedure if necessary to achieve clean area.

2. Pre-blasting Steel Preparation

a. Surface Treatment: In case of oil or grease contamination, solvent cleaning according to SSPC – SP – 1 using detergent or emulsion cleaners as Amercoat 57 (Oil and grease remover) or approved equivalent, followed by high pressure fresh water washing to remove all residues and to insure oil and or grease free areas. Degreasing procedure is to be repeated if necessary to achieve clean surface.

b. Grinding: Remove all surface imperfections as weld spatters, sharp fins… etc, sharp edges should be rounded. Welds undercuts and pinholes if detected should be filled with welding and grinded to ensure smooth surface.

c. Environmental Conditions: Measurement of ambient conditions should be done prior to abrasive blasting. Measurements can be done using sling psychrometer and psychrometer chart or by digital hygrometer to determine the air temperature, relative humidity and dew point. Steel temperature should be minimum 3ºC above dew point.

d. Measurement of ambient temperature should be checked prior to apply every coating film. The substrate temperature should be min. 3ºC above dew point.

3. Surface Preparation: Abrasive blast cleaned carbon steel to achieve a cleanliness degree SSPC – SP 6 /SSPC-Vis 1-89 or SA 2 ½ according to SIS 05 5900-1967 or ISO 8501-1 with anchor profile 35 to 50 microns as determined by replica tape /

Testex press –O– film tape according to ASTM 4417-91. method c. or similar instruments. Abrasives should be free of contamination as grease, oil, humidity, soluble salt…etc. Abrasives of blasting should achieve a 35 to 65 µ anchor profile as determined with testex Press –O– Film tape or similar approved instrument. Surface preparation should be followed by removal of dust and abrasive residues by brushing, followed by blowing off with clear dry air.

2.8 ANTI-CORROSIVE COATING SYSTEM

A. Corrosion: category C5 - M very high marine according to ISO 12944-5: paints and varnishes corrosion of steel structures by protective paint systems.

B. For zinc rich primers as per ISO 12944 -5: 5.2 the minimum zinc dust pigment content of the non-volatile portions of the paint shall be 80% by mass (m/m) both of organic and inorganic binders. The zinc dust pigment shall comply with the requirements specified in ISO 3549.

C. Application of primer:

1. Apply Zinc rich primer @ 75 microns dry film thickness, using spray gun as soon as possible after surface preparation and de-dusting, (within 4 hours @ Relative humidity less than 65%). Welds, inaccessible areas and sharp edges can be done by brush. Double coat all welds and sharp edges
2. After curing, check dry film thickness, if less than specified; apply additional coat and as needed to achieve the recommended dry film thickness.
3. Application of 107 microns wet film thickness of Zinc rich primer will normally provide 75 microns dry film thickness. (Over coating time @ 75 microns DFT- is minimum 4 hours @ 20°C) Zinc rich primer may be used to repair itself or inorganic zinc coatings.

D. Application of intermediate coat:

1. Before over coating Zinc reach epoxy ensure that surface is clean and free from zinc salts and contamination. Apply the 2 pack polyamide cured epoxy @ 175 microns DFT. Spray application is recommended to insure a proper and homogeneous film and appearance.
2. Application of 223 microns wet film thickness will normally provide 175 microns dry film thickness.
3. After curing, check dry film thickness, if less than specified; apply additional coat and as needed to achieve the recommended dry film thickness.

E. Application of final coat

1. Apply aliphatic polyurethane over clean and cured polyamide cured epoxy. Nominal dry film thickness is 100 microns

F. Mixing, application and drying of different coating films.

1. The mixing ratio is to be done in accordance with the coating supplier recommendation.
2. To avoid faulty mixing, partial mixing should be reduced to the minimum and only for touch up of small damaged areas
3. Coatings should be thinned only with thinners recommended by the coating manufacturers.

4. Mixing of different coating films from different coatings suppliers is not accepted
5. To insure the proper adhesion and the maximum performance of the coating system, a strict adherence to the recommendations of the coating supplier concerning curing and over coating time is a must
6. Refer to the application equipments as fluid tips, air caps, pump ratio...etc listed by the coating supplier as a guide; however, other equivalent equipments from other suppliers can be used. In both cases, adjustments of pressure and change of tip size may be needed to obtain the proper spray characteristic and the convenient atomization.
7. Dry film thickness readings: Measurements of dry film thickness of the priming coat and other coats of the paint system may be done separately. Measurements of dry film thickness is to be done as described in ISO 2808:1991 (E) or in accordance with BS EN ISO 2808
8. Colours and finishes: to the selection of the Engineer.

2.9 ANTI-CORROSIVE AND INTUMESCENT COATING SYSTEM

A. Application of primer:

1. Apply Zinc rich primer @ 75 microns dry film thickness, using spray gun as soon as possible after surface preparation and de-dusting, (within 4 hours @ Relative humidity less than 65%). Welds, inaccessible areas and sharp edges can be done by brush. Double coat all welds and sharp edges
2. After curing, check dry film thickness, if less than specified; apply additional coat and as needed to achieve the recommended dry film thickness.
3. Application of 107 microns wet film thickness of Zinc rich primer will normally provide 75 microns dry film thickness. (Over coating time @ 75 microns DFT- is minimum 4 hours @ 20°C) Zinc rich primer may be used to repair itself or inorganic zinc coatings

B. Application of Intumescent coating:

1. Before over coating Zinc reach epoxy, ensure that surface is clean and free from zinc salts and contamination. Apply Intumescent coating @ the recommended dry film thickness.
2. Dry film thickness should be applied as per the loading tables and the HP / A of each steel section.
3. As indication only, the application of 700 microns wet film thickness of Intumescent coating will normally provide 476 microns dry film thickness.
4. After curing, check dry film thickness, if less than specified; apply additional coat and as needed to achieve the recommended dry film thickness.
5. Thinning of Intumescent coating is not recommended.

C. Application of final coat:

1. Apply aliphatic polyurethane over clean and cured Intumescent coating. Nominal dry film thickness is 50 microns.

D. Mixing, application and drying of different coating films:

1. The mixing ratio is to be done in accordance with the coating supplier recommendation.
2. To avoid faulty mixing, partial mixing should be reduced to the minimum and only for touch up of small damaged areas
3. Coatings should be thinned only with thinners recommended by the coating manufacturers.
4. Mixing of different coating films from different coatings suppliers is not accepted
5. To insure the proper adhesion and the maximum performance of the coating system, a strict adherence to the recommendations of the coating supplier concerning curing and over coating time is a must
6. Refer to the application equipments as fluid tips, air caps, pump ratio...etc listed by the coating supplier as a guide; however, other equivalent equipments from other suppliers can be used. In both cases, adjustments of pressure and change of tip size may be needed to obtain the proper spray characteristic and the convenient atomization.

E. Dry film thickness readings: Measurements of dry film thickness of the priming coat and other coats of the paint system may be done separately. Measurements of dry film thickness is to be done as described in ISO 2808:1991 (E) or in accordance with BS EN ISO 2808.
   1. Colours and finishes: to the selection of the Engineer.

2.10 SCRATCHED PAINT AND ELASTIC ACRYLIC PAINT FOR EXTERNAL APPLICATION (FACADES)

A. Material: 100% pure acrylic paint.

B. Composition: Acrylic binder, pigments and fillers

C. Description: complies with requirements for exterior applications and UV resistant.

1. Water-tight, protecting the structure from moisture.
2. Vapor permeabile, allowing the structure to breathe.
3. Elastic, resistant to cracks and scratches and resistant to changing atmospheric conditions.
4. Abrasion resistant
5. Strong bonding.
6. Limiting the development of fungi and algae on the surface of the paint
7. Washable.

D. Number of coats: 1 coat of primer and minimum two coats of top coats. Primer shall be compatible with finish coat and recommended by Manufacturer.

E. Total dry film thickness (DFT): minimum 150 microns.

F. Putty: Surfaces where indicated shall receive one or more applications of putty filler until smooth surface is obtained to the Engineer's approval.

G. Finish: semi-gloss finish unless otherwise directed by the Engineer.

1. Color: as directed by the Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.

1. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.

2. Start of application is construed as Applicator's acceptance of surfaces within that particular area.

B. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

a. Confirmation of primer's suitability for expected service conditions.

b. Confirmation of primer's ability to be top coated with materials specified.

2. Notify the Engineer about anticipated problems before using the coatings specified over substrates primed by others.

C. Examine substrates and conditions, with applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

1. Maximum Moisture content of substrates: when measured with an electronic moisture meter as follows:

a. Concrete: 12%.

3.2 PREPARATION

A. Comply with manufacturer’s written instructions and recommendations in “MPI Architectural Painting Specification Manual” applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

C. Cleaning: Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces.

D. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove primers and reprime substrate.
2. Cementitious Substrates: Prepare concrete, concrete masonry block, and cement plaster surfaces to be coated. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods to prepare surfaces.
   a. Use abrasive blast-cleaning methods if recommended by coating manufacturer.
   b. Use stone or diamond grinder for surface preparation if recommended by coating manufacturer.
   c. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not coat surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
3. Steel Substrates: remove rust and loose mill scale using methods recommended in writing by coating manufacturer.
4. Galvanized-Metal substrates: remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

E. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

3.3 APPLICATION

A. General: Apply high-performance coatings according to manufacturer's written instructions.

1. Use applicators and techniques best suited for the material being applied.
2. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
3. Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.
4. Provide finish coats compatible with primers used.
5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, grilles, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
   a. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

b. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required is the same regardless of application method.

a. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.

b. Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.

c. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until coating has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause undercoat to lift or lose adhesion.

2. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

C. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.

b. Brush out and work brush coats into surfaces in an even film.

c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.

3. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.

a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.

b. Apply each coat to provide the equivalent hiding of brush-applied coats.

c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

D. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Block Fillers: Apply block fillers to concrete and masonry block at a rate to ensure complete coverage with pores filled.

F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

G. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.4 POLYURETHANE COATING SYSTEMS APPLICATION

A. After the concrete substrate is grinded with and then cleaned from dust and laitance, the substrate shall be checked for cleanliness and dryness.

B. Apply a primer coat using a roller or an airless spraying gun as instructed by Manufacturer.

C. Once the priming layer is dry and tack free, apply a basecoat layer at 25 mils thickness and when it is still tacky, silica sand size (1.0-1.2 mm) shall be be fully broadcasted.

D. After basecoat full drying; apply two layer of topcoat at 12 mils thickness each as instructed by system Manufacturer.

3.5 FIELD QUALITY CONTROL

A. Contractor shall supply labour, materials, properly calibrated instruments, power, etc., required for testing, unless otherwise indicated.

B. Type and duration of tests shall be determined by authorities having jurisdiction as the Engineer.

C. Engineer reserves the right to invoke the following procedure at any time and as often as Engineer deems necessary during the period when coatings are being applied:

1. Engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Engineer.

2. Testing agency will perform appropriate tests for the following characteristics as required by Employer:

a. Quantitative materials analysis.

b. Absorption.

c. Accelerated weathering.

d. Accelerated yellowness.

e. Color retention.

f. Alkali and mildew resistance.

g. Abrasion resistance.

h. Apparent reflectivity.

i. Washability.

j. Dry opacity.

k. Recoating.

l. Skinning.

3. Engineer may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

D. Replace or repair any damages resulting from tests, as directed by the Engineer.

E. The paint that fails to provide a uniform appearance, or fails to be clearly visible during the day or night, shall be corrected or replaced by the Contractor in a manner acceptable to the Engineer with no additional costs.

3.6 CLEANING

A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.7 PROTECTION

A. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Engineer, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.

2. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract and General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Regulatory and informatory signs and boards

B. For technical requirements of all external visible elements Contractor shall comply with the Specifications in this section. However, for aesthetic requirements Contractor shall comply with the Landscape Drawings and the Landscape Architect Specifications.

1.3 PERFORMANCE REQUIREMENTS

A. Design Criteria: Design, fabricate, and install exterior post and traffic signs to withstand a wind velocity of 100 km/h on the total sign area, in all directions.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign.
B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Supervision Consultant’s approval.
C. Shop Drawings: Include plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details.
D. Maintenance Data: For signage cleaning and maintenance requirements to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each sign type through one source from a single manufacturer.
B. Regulatory Requirements: Comply with the International standards and with code provisions as adopted by authorities having jurisdiction.

1.6 DELIVERY AND HANDLING

A. Delivery: Provide protective covering or crating as recommended by the manufacturer to protect sign components and surfaces against damage during transportation and delivery.
B. Handle signs carefully to prevent breakage, surface abrasion, denting, soiling, and other defects. Comply with the manufacturer's written handling instructions for unloading components subject to damage.

1. Inspect sign components for damage on delivery.
2. Do not install damaged sign components.
3. Signs delivered to the Site shall be stored off the ground and under cover in an approved manner.

4. Any sign damaged, discolored, or defaced during transportation, storage, or erection will be rejected.

1.7 WARRANTY

A. Warranty Period: Ten years from date of Taking Over Certificate of the whole of the Works

1.8 PROJECT CONDITIONS

A. Field Measurements: Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

1.9 COORDINATION

A. For signs supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for placement of anchorage devices and similar items to be used for attaching signs.

1. For signs supported by or anchored to permanent construction, furnish templates for installation of anchorage devices.

B. Coordinate location of remote transformers with building construction. Ensure that transformers are accessible after completion of Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Surface: High-strength, cold-rolled 0.75mm aluminum, flat front, non-aggressive ends, completely frameless surface also not showing any apparent bolts or frames
B. Back structure components: PVC support ribs, Black anodized aluminum vertical rails.
C. Finishes: Aluminum panels painted
D. Modular panels completely and easily interchangeable.
E. Fixation with screws or 3M double tape in special cases (on glass)
F. Surface mounted LED self-illuminating signs with batteries as per manufacturer requirement and approval of the Engineer.
G. For ceiling mounted products: Stainless steel suspension cables
H. Stainless steel panels, grade 316, with stainless steel fixations, of types, dimensions and finishes as shown on drawings.
I. For the free standing signs: extruded aluminum section 2.5mm thick and aluminum plate 2.5mm thick.
J. Vinyl lettering as per manufacturer requirement and approval of the Engineer.
K. Finish: natural anodized aluminum
L. Fixation: anchored to a concrete foundation by three anchor ties through three holes in an invisible 5mm thick stainless steel plate laser cut to the rectangular profile

2.2 SIGN PANEL

A. General: Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
B. All sign panels shall be fabricated true to the shapes and sizes indicated (with a max. tolerance of 10-15 mm)
C. Graphic Content and Style: Provide sign copy that complies with requirements indicated on Drawings for size, style, spacing, content, mounting height and location, material, finishes, and colors of signage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
B. Examine supporting members to ensure that surfaces are at elevations indicated.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.

3.3 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Employer.

SECTION 105113 - METAL LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Contract and Employer's General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Standard duty lockers, including the following:
   a. Double tier and single tier where indicated.
2. Locker benches if required.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for concrete bases.
2. Division 6 Section "Miscellaneous Rough Carpentry" for wood furring andgrounds.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker and bench.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer's approval.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.

1. Show locker fillers, trim, base, sloping tops, and accessories. Include locker-numbering sequence.

D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.

E. Samples for Verification: For the following products, in manufacturer's standard sizes, showing the full range of color, texture, and pattern variations expected. Prepare Samples from the same material to be used for the Work.

1. Lockers.
2. Locker benches.

F. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals specified in Employer's General Requirements.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain locker units and accessories through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver lockers until spaces to receive them are clean, dry, and ready for locker installation.

B. Protect lockers from damage during delivery, handling, storage, and installation.

C. Deliver master keys, control keys, and combination control charts to Employer.

1.6 WARRANTY

A. Provide the manufacturer's minimum five years warranty for materials and workmanship, from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Fitzpatrick

2. Best Metal.

3. Approved equal.

2.2 MATERIALS

A. Galvanized Steel Sheet: ASTM A 653M, commercial quality, Z180 coating designation; mill phosphatized; suitable for exposed applications, and stretcher leveled or roller leveled to stretcher-leveled flatness.

B. Fasteners: Zinc- or nickel-plated steel, slotless-type exposed bolt heads, and selflocking nuts or lock washers for nuts on moving parts.

2.3 STANDARD DUTY LOCKERS

A. Body: Form backs, tops, bottoms, sides, and intermediate partitions from steel sheet; flanged for double thickness at back vertical corners. Comply with the following:

1. Back-Material Sheet Thickness: 1.00 mm minimum.

2. Side-Material Sheet Thickness: 1.00 mm minimum.

3. Exposed Ends: Form exposed ends of nonrecessed lockers from minimum 1.50-mm thick steel sheet.

B. Frames: Form channel frames from minimum1.50-mm- thick steel sheet; lapped and welded at corners. Form continuous integral door strike on vertical frame members. Provide resilient bumpers to cushion door closing.

1. Latch Hooks: Form from minimum 2.70-mm thick steel; welded or riveted to door frames.

2. Cross Frames: Form intermediate channel cross frames between tiers from minimum 1.50-mm- thick steel sheet. Weld to vertical frame members.

C. Doors: One-piece steel sheet formed into channel shape at vertical edges and flanged at right angles at top and bottom edges. Fabricate to prevent springing when opening or closing, and to swing 180 degrees. Comply with the following:

1. Sheet Thickness: 1.50 mm minimum.

2. Reinforcing and Sound-Dampening Panels: Brace or reinforce inner face of doors with manufacturer's standard reinforcing angles, channels, or stiffener panels.

3. Louvered Vents: Stamped, louvered vents in door face, as follows:

a. Double-Tier Lockers: No fewer than three louver openings at top and bottom.

4. Security Vents: Manufacturer's standard arrangement of stamped horizontal or vertical security vents on door face.

D. Shelves: Provide hat shelf; fabricated from minimum 0.60-mm- thick, formed steel sheet; flanged on all edges.

E. Hinges: Steel, full loop, seven knuckle; tight pin; minimum 51 mm high. Weld to inside of door frame and attach to door with at least two factory-installed fasteners that are completely concealed and tamper resistant when door is closed.

1. Provide at least three hinges for each door more than 1067 mm high and at least two hinges for each door 1067 mm high or less.

F. Recessed Handle and Latch: Manufacturer's standard housing, formed from 0.90- mm- thick nickel-plated steel or stainless steel, with integral door pull, recessed for latch lifter and locking devices; nonprotruding latch lifter; and automatic, prelocking, pry-resistant latch, as follows:

1. Provide minimum three-point latching for each door more than 1067 mm high; minimum two-point latching for each door 1067 mm high or less.

a. Provide strike and eye for padlock.

2. Provide single-point gravity or spring-actuated latch with padlock lug.

2.4 LOCKS

A. Fabricate lockers to receive the following locking devices, installed on lockers using security-type fasteners:

1. Key Locks: Built-in flush locks with five-pin tumbler keyway, keyed separately and master keyed. Furnish two cut keys for each lock and five cut master keys. Comply with the following:

a. Key Type: Grooved.

b. Bolt Operation: Manually locking dead bolt or automatically locking spring bolt, as standard with manufacturer.

2.5 LOCKER ACCESSORIES

A. Interior Equipment: Furnish each locker with the following items, unless otherwise indicated:

1. Hooks: Manufacturer's standard zinc-plated, ball-pointed steel. Provide one double-prong ceiling hook, and not fewer than two single-prong wall hooks for, double-tier units. Attach hooks with at least two fasteners.

2. Coat Rods: Manufacturer's standard galvanized steel. Provide rod in lieu of ceiling hook for lockers 457 mm deep or greater.

B. Number Plates: Manufacturer's standard etched, embossed, or stamped, aluminum number plates with numerals at least 9 mm high. Number lockers in sequence indicated. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.

C. Continuous Metal Base: Minimum 1.50-mm- thick steel sheet, channel or zee profiled for stiffness, fabricated in lengths as long as practicable to enclose base and base ends of lockers, and finished to match lockers.

1. Height: 100 mm.

D. Individually Sloping Tops: Manufacturer's standard, fabricated from minimum 0.60-mm-thick steel sheet, for installation in place of flat locker tops. Fabricate tops in width to fit one locker frame, with integral back, finished to match lockers. Provide fasteners, filler plates, supports, and wedge-shaped divider panels for each locker upright.

E. Filler Panels: Manufacturer's standard; fabricated from minimum 1.20-mm- thick steel sheet in an unequal leg angle shape, and finished to match lockers. Provide slip joint filler angle formed to receive filler panel.

F. Finished End Panels: Manufacturer's standard; fabricated from minimum 0.60- mm- thick steel sheet, finished to match lockers, and designed for concealing exposed ends of nonrecessed lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

G. Center Dividers: Manufacturer's standard; fabricated from minimum 0.60-mmthick steel sheet, full-depth, vertical partitions between bottom and shelf, and finished to match lockers.

2.6 LOCKER BENCHES

A. Bench Tops: Provide manufacturer's standard one-piece units, of the following material, minimum 240 mm wide by 32 mm thick, with rounded corners and edges:

1. Laminated maple with one coat of clear sealer on all surfaces, and one coat of clear lacquer on top and sides.

B. Pedestals: Provide manufacturer's standard pedestal supports, with predrilled fastener holes, complete with fasteners and anchors, and as follows:

1. Type: Tubular steel, minimum 38-mm diameter, threaded on both ends, with standard pipe flange at top and bell-shaped cast base; baked-enamel finish; floor anchored with concealed fasteners.

2. Color: As selected by Engineer from manufacturer's full range.

C. Furnish a minimum of two pedestals for each bench, with pedestal spacing not more than 1820 mm o.c.

2.7 FABRICATION

A. Unit Principle: Fabricate each locker with an individual door and frame, individual top, bottom, back, and shelves, and common intermediate uprights separating compartments.

B. Knocked-Down Construction: Fabricate lockers for nominal assembly at Project site.

C. Fabricate lockers square, rigid, and without warp, with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch. Weld frame members together to form a rigid, one-piece assembly.

1. Form locker-body panels, doors, shelves and accessories from one-piece steel sheet, unless otherwise indicated.

2.8 FINISHES, GENERAL

A. Finish all steel surfaces and accessories, except prefinished stainless-steel and chrome-plated surfaces.

B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 GALVANIZED STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

B. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-enamel finish consisting of a thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 0.036 mm on doors, frames, and legs, and 0.028 mm elsewhere.

1. Color and Gloss: As selected by Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine concrete bases for suitable conditions where metal lockers are to be installed.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install metal lockers and accessories level, plumb, rigid, and flush according to manufacturer's written instructions.

B. Assemble knocked-down lockers with standard fasteners, with no exposed fasteners on door faces and face frames.

C. Connect groups of all-welded lockers together with standard fasteners, with no exposed fasteners on face frames.

D. Anchor lockers to floors and walls at intervals recommended by manufacturer, but not more than 910 mm o.c. Install anchors through backup reinforcing plates where necessary to avoid metal distortion, using concealed fasteners.

E. Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed lockers with concealed clips.

2. Attach sloping top units to lockers, with closures at exposed ends.

F. Attach boxed end panels with concealed fasteners to conceal exposed ends of nonrecessed lockers.

G. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed lockers.

H. Anchor locker benches to floors,uniformly space pedestals not more than 1830 mm apart, and securely fasten to bench top and anchor to floor.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.

B. Clean interior and exposed exterior surfaces and polish stainless-steel and nonferrous-metal surfaces.

C. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit locker use during construction.

D. Touch up marred finishes, or replace locker units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

SECTION 105613 - METAL STORAGE SHELVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Contract and Employer’s General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Provide steel storage shelving units and accessories, complete, as shown on drawing and as specified.

2. Stainless steel racks

B. Related Sections include the following:

1. Division 10 Section "Metal Lockers.

2. Division 6 Section "Miscellaneous Rough Carpentry" for wood furring andgrounds.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal storage shelving.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.

1. Show storage shelving, trim, base, sloping tops, and accessories.

D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.

E. Samples for Verification: For the following products, in manufacturer's standard sizes, showing the full range of color, texture, and pattern variations expected. Prepare Samples from the same material to be used for the Work.

1. Powder coated finish steel storage shelving .

F. Maintenance Data: For adjusting, repairing, and replacing storage shelving include in maintenance manuals specified in Employer’s General Requirements.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain steel storage shelving units and accessories through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver steel storage shelving until spaces to receive them are clean, dry, and ready for shelving installation.

B. Protect shelving from damage during shipping, handling, storage and installation. Dents, deformations, and defacements are not acceptable. If storage at project is necessary before installation can be accomplished, store such materials in a clean, dry place. Replace all damaged materials. Damaged parts may be replaced within a complete assembly, provided replacements are of the same quality, size, shape, color and other requirements.

1.6 WARRANTY

A. Provide the manufacturer’s minimum five years warranty for materials and workmanship, from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials supplied shall be of proper size, shapes, colors or other requirements. Properly mark for location of installation. Provide full instructions for the assembly of all units which are shipped KD (knocked-down). Adequately mark or otherwise indicate all parts required for full assembly.

B. Open Shelving: Shelving shall be manufacturer's standard prefinished open (rack) units arranged as shown.

C. Width(s), height(s) and depths of units, shelf arrangement and spacing, shall be as shown; field assembled with clips and without special tools, except as otherwise indicated
   1. Provide open units with beaded or angle front post and side and back sway and seismic bracing, with accessories as shown or required for complete shelving.

D. Stainless steel racks grade 316, heavy duty storage racks shall be manufacturer's standard prefinished including supports, steel organizer wire rack and all necessary fixing accessories

2.2 FINISH

A. Manufacturer's standard factory applied baked on enamel finish over phosphatized surfaces on all shelving components, except as otherwise indicated. Color shall be as selected by the Engineer.

2.3 SHELVING COMPONENTS

A. Adjustable shelving with interchangeable steel components.Components shall be as follows:
   1. Posts for Open Shelving Unit.

   2. Shelves: Box formed shelves with face and return flange on at least front and rear edges

3. Shelf Clips: Manufacturer's standard cadmium plated shelf clips to hold shelf securely in place; clips and shelves easily installed without tools; provide 4 clips per shelf.

4. Sway and Seismic Braces: Diagonal cross bracing or solid panel bracing; bolt to posts. Provide angle or corner sway braces bolted to shelves and posts where indicated.

5. Accessories: Manufacturers standard accessories, including zinc coated bolts, nuts, clips

PART 3 - .EXECUTION

3.1 INSTALLATION

A. Install metal shelving units in a secure manner, to solid blocking, in accordance with the recommendations of the manufacturer for the installation involved, and with the detailing shown. Install work rigid, level, and plumb. All moving parts shall operate freely. Perform all installation in accordance with the manufacturer's directions. Where special fastenings or like materials are required, supply as recommended by the manufacturer of the item.

B. Protect finish surfaces of adjacent materials with tape, paper or other materials. Make fastenings as inconspicuous as possible. Remove sharp edges or burrs. Make final adjustment of moving parts immediately prior to final inspection of the work of the Project.

SECTION 122423 – ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Roller window shades, manual.
2. All other related fixings and accessories

B. Related Sections include the following:

1. Division 05 Section “Structural Steel”.
2. Division 05 Section "Metal Fabrications".
3. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.3 SUBMITTALS

A. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

B. Product Data: Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, finishes, and operating instructions for roller shade.

C. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension system members and attachment to building structure.

E. Samples for Initial Selection: For each colored or finished component of each type of roller shade indicated.

1. Include Samples of graphics on fabric.
2. Include similar Samples of accessories involving color selection.

F. Samples for Verification: For each of the following products and for the full range of color, texture, and pattern variations required, prepared on Samples of size indicated below. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1. Roller shade Fabric: 300 mm square section of fabric from dye lot to be used for the Work, with specified treatments applied. Mark face of fabric.
2. Graphics: Not less than 300 mm square section showing graphics application method.
3. Seam, Edge, and Corner Condition: Not less than 300 mm long section showing seam, edge, and corner treatment.
4. Valance: Full-size unit, not less than 300 mm long.
5. Frame Finish: Not less than150 mm lengths.
6. Accessories: Manufacturer's full-size unit.

G. Product Certificates: For each type of roller shade fabric, signed by product manufacturer.

H. Welding certificates.

I. Qualification Data: For Installer, fabricator and professional engineer.

J. Research/Evaluation Reports: For anchors and fasteners.

K. Maintenance Data: For roller shade to include in maintenance manuals. Include the following:

1. Methods for maintaining roller shade fabrics and finishes.
2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
3. Operating hardware.

L. Warranty: Special warranty specified in this Section.

1.4 QUALITYASSURANCE

A. Installer Qualifications: Fabricator of roller shade.

B. Fabricator Qualifications: Firm that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

C. Source Limitations: Obtain roller shade through one source from a single manufacturer.

D. Product Standard: Provide roller shades complying with WCMA A 100.1.

E. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."

F. Fire-Test-Response Characteristics: Provide roller shade fabrics with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Resistance Ratings: Passes NFPA 701.
2. Permanently attach label to each roller shade fabric indicating whether fabric is inherently and permanently flame resistant, or treated with flame-retardant chemicals, and whether it will require retreatment after designated time period or cleaning.

G. Mockups: Before installing roller shade, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution and set quality standards for fabrication and installation.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire test response characteristic and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.6 PROJECTCONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where sunscreen installation is indicated to fit to other work, verify dimensions of other work by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for fenestration operation throughout the entire operating range. Notify the Engineer of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.7 WARRANTY

A. Special Warranty: Written warranty by manufacturer in which manufacturer and fabricator agree to repair or replace components of roller shade that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including framework.
   b. Faulty operation of operator.
   c. Deterioration of fabric including seam failure.
   d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Fabric Warranty Period: Five years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 ROLLER SHADE FABRICS

A. Manufacturers:

1. Roller shade: Helioscreen, Levolux, Guthrie Douglas or approved equal.

2.2 ROLLER SHADE FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Lifting Mechanism: With permanently lubricated moving parts.

C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 23 deg C:

1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 6 mm from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
2. Shade Units Installed Outside Jambs: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting facia roller, and operating hardware and for hardware position and shade mounting method indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

G. Colors of Metal and Plastic Components Exposed to View: as selected from manufacturer’s full range, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for supporting members, blocking, inserts, installation tolerances, operational clearances, lighting, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Install roller shades level at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.

B. Install roller shades after other finishing operations, including joint sealing and painting, have been completed.

C. Attach fabric to frames as recommended by fabricator, using fabric hem pockets to ensure tight, wrinkle-free fit of fabric to frame.

D. Slip fit frame connections accurately together to form hairline joints and tighten to secure.

E. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

1. Field Welding: Comply with the following requirements:

a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

b. Obtain fusion without undercut or overlap.

c. Remove welding flux immediately.

d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation accessories where necessary for securing sunscreens to structural support and for properly transferring load to in-place construction.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.3 ADJUSTING

A. Adjust roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades.

SECTION 125000 - FURNITURE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes manufactured and custom made furniture.

B. Related Sections include the following:

1. Division 6 Section "Rough Carpentry".
2. Division 6 Section "Interior Architectural Woodwork”.
3. Division 9 Section "Interior Painting”.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated (all furniture items). including but not limited to the following:

1. Bed, drawers and mattress.
2. Desk
3. Shelves.
4. Storage cabinet
5. Examination bed to first aid clinic
6. Desk chair to first aid clinic
7. Visitor chair to first aid clinic
8. Desk chair to main control room
9. Chair
10. Arm chair
11. Stool chairs
12. Reception desk chairs
13. Chairs for meeting room
14. Dining chairs
15. Sofa,
16. Wooden cabinets with epoxy resin work-surface.
17. Closet.
18. Lockers

19. Reception desk.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for the Supervision Consultant's approval.

C. Samples for Initial Selection: For each of the custom made furniture.

D. Samples for Verification:

1. Wood-veneered panels with transparent finish, 200 by 250 mm, for species
2. Solid wood with transparent finish, 300 sq.cm, for each species.
3. Solid wood trim with transparent finish, 200 mm long, for each species.
4. Laminated and Veneer for Finish, 200 by 250 mm.
5. Exposed hardware, for each type of item.

E. Product certificates: signed by manufacturers of furniture certifying that products furnished comply with requirements.

F. Shop Drawings: For Custom made furniture. Include plans, elevations, details, and attachments to other works. Show materials, finishes, filler panels, edge profiles, and methods of jpoints.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified..

H. Source quality-control test reports.

I. Warranty: For materials and workmanship.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed furniture and woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Fabricator Qualifications: A firm experienced in producing furniture similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production and installation of furniture with sequence-matched wood veneers including wood doors where veneer matching includes door faces.

D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork, construction, finishes, and other requirements.

1. Provide AWI certification labels or compliance certificate indicating that woodwork complies with requirements of grades specified.

2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with such selections and requirements in addition to the quality standard.

E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver furniture to Project Site in such quantities and at such times to ensure continuity of installation.

B. Support furniture during shipment on non-staining shock-absorbing material.

C. Place stored furniture so identification marks are clearly visible, and furniture can be inspected.

D. Handle and transport furniture in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

E. Store furniture at project site to prevent cracking, staining, or other physical damage to protective finish coatings.

F. Do not deliver furniture/woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install furniture until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Established Dimensions: where custom made furniture is indicated to fit to other construction, establish dimensions foe areas where furniture is to fit. Coordinate construction to ensure that actual dimensions correspond to established dimension. Provide fillers and scribes to allow for trimming fitting.

C. Field Measurements: where custom furniture is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on shop drawings. Provide fillers and scribes to allow for trimming fitting.

1.7 COORDINATION

A. Coordinate layout and installation of blocking and reinforcement in partitions for support of custom made furniture.

B. Coordinate locations of utilities that will penetrate custom made furniture.

1.8 WARRANTY

B. Furniture Manufacturer's Warranty: Provide written Warranty, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective furniture that do not fulfill quality and performance requirements or do not comply with tolerances in referenced quality standard such as, but not limited to:

1. Structural failures.

2. Faulty operation of movable parts and hardware.

3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. Warranty Period: 10 years from date of Taking Over Certificate of the whole of the Works

PART 2 - PRODUCTS

2.1 GENERAL

A. Furniture items have been selected by the interior designer with reference to manufacturer, catalogue number, item reference, and to layout drawings for custom made and manufactured furniture.

B. Refer to FF&E selection booklets, where materials, product references, manufacturers and suppliers are indicated.

C. Hardware: Manufacturer’s standard units complying with BHMA A156.9, of type, size, style, material and finish.

D. For hardware Refer to section 087100 “door hardware”

PART 3 - Execution

3.1 Installation

A. Install furniture in designated locations.

B. Install custom made and manufactured furniture with no variations in flushness of adjoining surfaces, use concealed shims. Where furniture abut other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match cabinets faces.

C. Install custom made and manufactured furniture without distortion so doors and drawers fit openings and are aligned. Complete installation of hardware and accessories as indicated.

3.2 Adjusting and cleaning

A. Adjust furniture and hardware so doors and drawers are centered in openings and operate smoothly without wrap or bind. Lubricate operating hardware as recommended by manufacturer.

B. Clean furniture on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damage or soiled areas.

SECTION 123640 - STONE COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes

1. Granite countertops for toilets.
2. Composite synthetic stone countertops for kitchens.

B. Related Sections include the following:

1. Division 9 Section "Stone Flooring".

1.3 SUBMITTALS

A. Product Data: For the following:

1. Each variety of stone.
2. Stone accessories and other manufactured products.

B. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for Engineer’s approval.

C. Shop Drawings: Include plans, sections, details, and attachments to other work.

D. Samples for Verification:

1. For each stone type indicated, in sets of Samples not less than 300 mm square. Include two or more Samples in each set and show the full range of variations in appearance characteristics expected in completed Work.

E. Qualification Data: For Installerand fabricator.

F. Sealant Compatibility Test Report: From sealant manufacturer, complying with requirements in Division 7 Section "Joint Sealants" and indicating that sealants will not stain or damage stone.

G. Maintenance Data: For stone countertops to include in maintenance manuals. Include Product Data for stone-care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

H. Warranty: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate stone countertops similar to that indicated for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products.

C. Source Limitations for Stone: Obtain each variety of stone from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.

1. Obtain each variety of stone from a single quarry, whether specified in this Section or in another Section of the Specifications.
2. Make stone slabs available for the Engineer to examine for appearance characteristics.
    a. The Engineer will select aesthetically acceptable slabs and will indicate aesthetically unacceptable portions of slabs.
    b. Segregate slabs selected for use on Project and mark backs indicating approval.
    c. Mark and photograph aesthetically unacceptable portions of slabs as directed by the Engineer.

D. Mockup: Build mockup to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical countertop as shown on Drawings.
2. Approved mockup may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

B. Store stone on wood A-frames or pallets with nonstaining separators and nonstaining, waterproof covers. Ventilate under covers to prevent condensation.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of construction to receive stone countertops by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace counter tops that fail in materials, or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Taking Over Certificate of the whole of the Works.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. LG
2. CORIAN by Dupont.
3. Or approved equal.

2.2 COMPOSITE SYNTHETIC STONE COUNTERTOPS

A. Components: 93% natural quartz blended with polymer resin and colorfast pigments.

B. Properties:

1. Coefficient of linear thermal expansion: 25~30 x 10-6 °K-1, UNE EN 14617-11.
2. Flexural strength: 40~47 Mpa, UNE EN 14617-2.
3. Scratch resistance: 7 Mohs., EN 101.
4. Impact resistance: 10-12J, UNE EN 14617-9.
5. Slip resistance: 15-19 USRV for polished, UNE EN 1341
6. Water absorption: 0.035 ~ 0.038%, UNE EN 14617-1
7. Chemical resistance: C4 (material keeps at least 80% of the reflection reference value after 8 hours of acid or basic attack.
8. Antibacterial.

C. Color: as selected by the Engineer and to match sample.

D. Finish: Polished, unless otherwise indicated on Drawings.

E. Thickness: As indicated or directed by the Engineer but not less than 30mm.

F. Edge details: As indicated or directed by the Engineer.

G. Cut outs and Holes: Make cut outs for toilet sinks in shop using template or pattern furnished by fixture manufacturer.

2.3 GRANITE COUNTERTOPS

A. Granite: Comply with ASTM C 615, shall have the following minimum physical properties.

1. Absorption by weight: 0.4% max. as per ASTM C97.
2. Density, min: 2,560 Kg/m³ as per ASTM C97.
3. Modulus of Rupture, min.: 1,500psi (10.34 MPa) as per ASTM C99.
4. Compressive strength, min: 19,000psi (131 MPa) as per ASTM C170.
5. Abrasion Resistance, min: Ha=25.0 as per ASTM C241.

6. Flexural Strength, min: 1,200psi (8.2 MPa) as per ASTM C880.
7. Chemical Resistance: Unaffected, ISO 10545.13

B. Color: as selected by the Engineer and to match sample.

C. Finish: as indicated on Drawings.

D. Thickness: Not less than 30mm unless otherwise indicated.

2.4 ADHESIVES, GROUT, SEALANTS, AND STONE ACCESSORIES

A. General: Use only adhesives formulated for stone and ceramic tile and recommended by their manufacturer for the application indicated.

B. Water-Cleanable Epoxy Adhesive: ANSI A118.3.

1. Available Manufacturers: Subject to compliance with requirements and to the approval of the Engineer.

C. Sealant for Countertops: Manufacturer's standard sealant of characteristics indicated below that comply with applicable requirements in Division 7 Section "Joint Sealants" and will not stain the stone it is applied to.

1. Single-component, neutral-curing silicone sealant.
2. Color: Clear.

D. Stone Cleaner: Cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer and, if a sealer is specified, by sealer manufacturer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

E. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

1. Available Manufacturers: Subject to compliance with requirements and to the approval of the Engineer.

2.5 STONE FABRICATION, GENERAL

A. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.

1. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by the Engineer.

B. Grade and mark stone for final locations to produce assembled countertop units with an overall uniform appearance.

C. Fabricate stone countertops in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.

1. Clean sawed backs of stones to remove rust stains and iron particles.
2. Cut and drill sinkages and holes in stone for anchors, supports, and attachments.

3. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
4. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile to produce uniform shape throughout entire length of edge and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units. Form corners of molded edges as indicated with outside corners slightly eased, unless otherwise indicated.
5. Finish exposed faces of stone to comply with requirements indicated for finish of each type of stone required and to match approved Samples and mockups. Provide matching finish on exposed edges of countertops, splashes, and cutouts.

D. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

2.6 STONE COUNTERTOPS

A. Nominal Thickness: Provide thickness indicated, but not less than 30 mm. Gage backs to provide units of identical thickness.

B. Edge Detail: As indicated.

C. Splashes: (20-mm-) thick backsplashesandend splashes, unless otherwise indicated.

1. Height: As indicated.
2. Top-Edge Detail: As indicated.

D. Cutouts and Holes:

1. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
   a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 5 mm into fixture opening.
2. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates indicated to receive stone countertops and conditions under which stone countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone countertops.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by stone countertop Installer for anchoring stone countertops. Furnish installers of other work with Drawings or templates showing locations of these items.

B. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives. Allow stone to dry before installing.

3.3 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1.5 mm in 1200 mm.

B. Variation from Level: Do not exceed 3 mm in 2400 mm, 6 mm maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/4 of nominal joint width.

D. Variation in Plane at Joints (Lipping): Do not exceed 0.4mm difference between planes of adjacent units.

E. Variation in Line of Edge at Joints (Lipping): Do not exceed 0.4mm difference between edges of adjacent units, where edge line continues across joint.

3.4 INSTALLATION OF COUNTERTOPS

A. General: Install countertops by adhering to supports with water-cleanable epoxy adhesive.

B. Do not cut stone in field, unless otherwise indicated. If stone countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.

C. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Shim and adjust stone to locations indicated, with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances. Install anchors and other attachments indicated or necessary to secure stone countertops in place.

D. Install backsplash and end splash by adhering to wall with water-cleanable epoxy adhesive and to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

E. Apply sealant to gaps specified for filling with sealant; comply with Division 7 Section "Joint Sealants." Remove temporary shims before applying sealant.

3.5 ADJUSTING AND CLEANING

A. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.

B. Remove and replace stone countertops of the following description:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by The Engineer.
2. Defective countertops.
3. Interior stone countertops and joints not matching approved Samples and mockups.
4. Interior stone countertops not complying with other requirements indicated.

C. Replace in a manner that results in stone countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.

D. Clean stone countertops not less than six days after completion of installation, using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.

E. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract.

1.2 SUMMARY

A. This Section includes the following:

1. Structural Excavating and backfilling.
2. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench

1.4 SUBMITTALS

A. Coordinate with the Engineer to establish the final level of platform for each area.

B. Product data for backfilling materials

C. Method statement: Prior to commencing any work, the Contractor shall submit a 'Method Statement' detailing how each item of work will be performed, including:

1. Leveling Plan
2. Excavation Plan
3. Filling Plan
4. List of tools, equipment and transport trucks to be used
5. Supervision and control system.

D. Samples and tests: Submit 50 kg representative samples of filling materials to an approved laboratory for tests as follows and submit results for approval.

1. For soils with less than 50% fines: sieve analysis and compaction.
2. For soils with more than 50% fines: sieve analysis, Atterberg Limits Compaction.
3. For all soils: test in accordance with ASTM D1557 (Method D) to determine the optimum amount of water to be used with fill material to obtain maximum dry density.

4. Tests shall be conducted for every source of filling materials and for every type of filling material encountered.Material.

E. Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill.

2. Laboratory compaction curve according to ASTM D 698 and ASTM D 1557 for each on-site and borrow soil material proposed for fill.

F. Relative compaction test results as well as all other laboratory test results submitted to the Engineer on a monthly basis, and kept in hand in the Contractor's on-site office so that they may be inspected at any time by the Engineer.

G. Quality control program.

H. Weekly and monthly quality control reports.

I. Analysis of the results of testing as required by compaction and testing of earthworks.

J. Survey measurements for tolerance control and payment purpose. Program of execution, calculation volume of excavations, periodicity of trucks, and fleet of trucks needed for the completion of the works within the program limits.

K. Dumping area, relative permits and/or sub-agreements.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

B. Surveyor Qualifications: An independent licensed surveyor, acceptable to the Engineer and experienced in ground surveys.

C. Quality Assurance, both Inspection and Acceptance, shall be conducted in accordance with the requirements of the engineer.

D. Tolerances according to BS 5606.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

PART 2 - PRODUCTS

2.1 WATER

A. Clean water shall be used in all Earthwork operations.

B. Portable water shall be used for compaction of backfill material within the area paid for as structural excavation or within an area of one meter from all surfaces of the structure, whichever is the greater.

C. The Contractor shall supply all water for construction including dust control, moisture-conditioning of fill material during compaction and such other needs as the Engineer may require.

2.2 MATERIALS ARISING FROM EXCAVATION

A. Materials and conditions: Assess the nature of the work and the materials to be excavated. Take sole responsibility for the assessment of materials and conditions.

B. Topsoil for preservation: Before beginning general excavation or filling, excavate topsoil from required areas and keep separate from excavated subsoil.

2.3 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Fill material shall be from one or more of the sources listed below:

1. Suitable materials from the required excavations within the site of the work. This shall be the primary source of fill material.
2. Borrow areas designated by the Engineer.
3. From approved on-land borrow areas provided by the Contractor
4. From approved commercial sources.

F. Designation or approval of a borrow area does not mean that all material within that area is suitable fill material. Only material from such areas that meets the specification requirements shall be placed in the works. The Contractor shall be responsible for ensuring that materials obtained from borrow areas comply with the requirements of the Specification.

G. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

H. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

I. Backfill and Fill: Satisfactory soil materials.

J. Topsoil: to BS 3882, medium texture, neutral to slightly alkaline reaction, free of stones, pests, weed seeds and foreign matter.

K. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

L. Stone Mulch: Water-borne and durable gravel, washed free of loam, sand, clay and other foreign substances, evenly graded from 5 mm minimum to 25 maximum size and of natural gravel colour to be approved.

M. Compacted cement granular fill: Materials to be used for composed cementitious fill shall be granular coarse grained soils from on-site excavation or borrow mixed with sulphate resistant cement at a ratio of 200 kg cement per cubic meter of fill. The constitution of the granular fill shall be similar to the above mentioned composition of compacted fill material. Laying of the cement granular fill shall be damped and compacted in order to have stabilized layer of base coarse. Curing shall be done for the following 48 hours. Cement granular fill shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface."

C. Protect and maintain erosion and sedimentation controls, during earthwork operations as specified by the engineer.

D. Waterways: Temporarily divert, as necessary, ditches, field drains and other waterways encountered during excavations, and reinstate on completion. If reinstatement is not possible obtain instructions.

3.2 SURVEY WORKS

A. The Contractor shall coordinate with the Engineer to establish the reference bench marks and the site zero level, to determine the reference points related to the performance of his works.

B. The Contractor shall assure the survey works needed for the execution of the earthworks and have a full time topographer to supervise team on site so to facilitate the day by day works.

C. At the request of the Engineer, the Contractor shall take the responsibility to put aside, within the area assigned by the Engineer, the excavation material to be re-used for filling and compaction.

D. The Contractor shall position the final levels and the boundary limits of the platforms whenever reached to the approval of the Engineer.

3.3 EXCAVATION

A. Methods: Submit details of proposed methods of working to avoid any nuisance, damage or danger to people and/or property.

B. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

C. No excavation material shall be wasted without written permission from the Engineer, and when such material is to be wasted, it shall be so placed that it will present a neat appearance and not be an injury to abutting property. Excavated materials wasted by the Contractor without written permission of the Engineer shall be replaced by the Contractor at his own expense

D. The Contractor shall provide all labors; equipment and material required for the construction of items of grading works as specified and shown on the final construction drawings.

E. Adjacent Excavations: Where an excavation encroaches below a line drawn at an angle from the horizontal of 45 degrees for dry stable soil or 30 degrees for wet clays or soils below water table from the nearest formation level of another higher excavation, then all work within the lower excavation and back-filling there must be completed before the higher excavation is made.

F. Foundations Generally : Inform the Engineer as have his guidance as approval whenever:

1. Natural bearing formation of undisturbed subsoil is not obtained at depth shown on the Drawings,
2. Formation contains soft or hard spots or highly variable material.

3.4 EXCAVATIONS FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

B. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand the bottom 200mm to final grade just before placing concrete blinding. Trim bottoms to required lines and grades to leave solid base to receive other work.

C. Final excavation to grade shall not be performed until just before the placement of reinforcing steel or concrete. When the bottom of the excavation is soil, the grade shall not be disturbed prior to the placement of concrete. When the bottom of the excavation is rock or other hard foundation material, it shall be cut to a firm surface as directed and all loose material removed. Any open seams shall be cleaned and filled with concrete, mortar or grout to the satisfaction of the engineer. Footing excavations shall be dewatered and made as dry as possible prior to the placement of backfill. Backfill material as specified shall be placed in lifts as directed and compacted as directed to the satisfaction of the engineer.

D. Anti-Termite Treatment: Destroy ant-nests and vermin encountered during excavations. Apply approved proprietary pesticide solution of Dieldrin or Aldrin or equivalent in clean water with a spray maintaining a pressure of 150 psi to surfaces of excavations at the rate recommended by the manufacturer.

E. Where footings are to be constructed using formwork, the excavations shall generally not extend more than 500 mm beyond the maximum dimension on each side of the proposed footing unless additional working space is clearly required and approved, by the Engineer.

F. Sides of Excavations: Responsibility for upholding sides of excavations rests upon the Contractor.

G. TEMPORARY SUPPORT SYSTEM

1. When a temporary support system is required to protect adjacent property or to protect the public during construction, the Contractor's design for such support system shall be submitted for approval prior to commencing its construction.

2. All temporary support systems shall be designed with adequate factors of safety to serve with minimal maintenance, for the duration of its intended use, and shall include adequate safety provisions to protect the public from construction activities.

3. Notwithstanding any approval of temporary support systems, the Contractor shall be solely responsible for the adequacy of their design and construction and for maintenance and all necessary safety precautions associated therewith.

4. Steel Sheet Piling: Use as necessary to support sides of excavations and remove upon completion unless otherwise instructed.

5. Special Support: Use as necessary to uphold excavations against sides of adjoining buildings, public footpaths, roads and the like, and remove on completion unless otherwise instructed.

H. Unstable Ground: Inform the Engineer without delay if any newly excavated face will not remain unsupported sufficiently long to allow necessary earthwork support to be inserted. If instability is likely to affect adjacent structures or roadways, take appropriate emergency action. Responsibility for preventing instability rests upon the Contractor.

I. Existing Foundations: Where old foundations, beds, drains etc. are encountered, obtain instructions before proceeding. Break out old foundations, beds, drains etc., seal off drain ends, remove contaminated earth, and disinfect as instructed.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide clearance of 300mm on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 300 mm higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 150 mm in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 150 mm or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
3. Excavate trenches 150 mm deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms, when bedding course is required under pipe: Excavate trenches 100 mm deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe

1. Excavate trenches 150 mm deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the slab on grade, with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

3.7 UNAUTHORIZED EXCAVATION

A. Any unauthorized over width of excavation beyond the lateral limits shown on the drawings or approved by the Engineer shall be backfilled with selected fill and compacted. Suitable fill material shall consist of uniformly graded granular material, capable of being compacted to 95% AASHTO T 180 maximum density, and having adequate permeability to permit free drainage through it and shall be cohesion less material, free of lenses, layers or other types of inclusions of material not meeting the requirements. This work shall be performed at the Contractor's expense.

B. Any unauthorized over-depth excavation below the approved elevation shall be backfilled with plain concrete of 15MPa compressive strength approved by the Engineer. This work shall be performed at the Contractor's expense.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

Stockpile soil materials away from edge of excavations.

3.9 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 13 mm when tested with a 3-m straightedge.

3.10 BACKFILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. No backfilling shall be performed before casting the slabs that support earth or retaining walls.

C. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

D. Place and compact fill material in layers to required elevations as follows:

Under structural slabs, use engineered fill.

Under footings and foundations, use engineered fill.

E. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

F. Surplus: Remove surplus imported filling materials from site

G. The Contractor shall notify the Engineer in writing, of his intent to start filling and compaction operations for each segment of the work.

H. Place Filling using approved methods to required dimensions, levels, lines and profiles and to permit water to drain freely.

I. Place backfill on subgrades free of mud.

3.11 UTILITY TRENCH BACKFILL (For existing Utility if any)

A. Place backfill on subgrades free of mud.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 450 mm of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

D. Provide 100-mm thick, concrete-base slab support for piping or conduit less than 750 mm below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 100 mm of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 25 mm in any dimension, to a height of 300 mm over the utility pipe or conduit.

F. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

H. Place and compact final backfill of satisfactory soil to final subgrade elevation

3.12 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill layer before compaction to within 2 percent of optimum moisture content.

B. Do not place fill material on surfaces that are muddy.

C. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF FILLS

A. Surfaces to receive filling shall be cleared and all vegetation removed off site before filling is placed. Surfaces of ground shall be scarified and recompacted to at least 95% of maximum dry density as determined by ASTM D1557 (Method D). Compaction shall be to a depth of at least 200 mm below ground surface.

B. Place fill materials in layers not more than 200 mm in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm in loose depth for material compacted by hand-operated tampers.

C. Place fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

D. Filling operations shall be carried out as soon as practicable after testing and shall be executed in a continuous operation. The filling shall be placed in uniform layers and each layer of material being compacted shall have the test practical uniform moisture content to ensure satisfactory compaction and all subject to the approval of the Engineer. Method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipes or other services.

E. Moisture content: Each layer of filling shall be moistened or dried to reach correct moisture content for required dry density. Spread and compact each layer to at least 95% of maximum dry density, unless otherwise specified, all as determined by ASTM D1557 (Method D). Each compacted layer shall be tested and approved prior to placing subsequent layers.

F. Earth Filling Generally: Shall be selected fill spread, and leveled in 200 mm maximum layers each well consolidated with a suitable mechanical hammer.

G. Deposit Earth Filling in a manner not to endanger the partly finished structure or sub-structure either by direct pressure or indirectly by overloading banks contiguous to the operation or in any other manner.

H. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures and building slabs, scarify and recompact top 300 mm of existing subgrade and each layer of fill material at 95 percent.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Perform tests at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 186 sq. m or less of paved area or building slab, but in no case fewer than three tests.

2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each (30 m) or less of wall length, but no fewer than two tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each (46 m) or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

F. Compliance Survey: Conduct a survey of completed Earthwork to show grading compliance.

3.15 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Topsoil for Preservation: Stockpile excavated topsoil required to carry out subsequent top soiling operations in temporary spoil heaps on site as instructed.

B. Surplus Subsoil: Remove from site to a tip, surplus excavated materials not required for filling, spreading and levelling or stockpiling

C. Tips: Use only authorised tips for disposal of surplus excavated material removed from site. Pay all tipping fees

D. Water: Keep excavations free from water and keep water from excavations clear of other work.

E. Pumping: Do not disturb material in and around excavations by pumping operations.

F. Sumps: Obtain approval of location of any sump, and fill with approved material when no longer required.

G. Permanent Drainage System shall not be used for disposal of water from excavations without approval.

3.17 Found Objects

A. Particularly, refer to government's regulations concerning remains of historic monuments, ruins or objects concerning prehistory, history, art, archaeology, humanistic, etc... When discovering war vestiges such as arms, ammunition explosive weapons or alike:

1. Clear danger zone from people;
2. Advise immediately concerned authorities;
3. Advise the Engineer;
4. Provide a safety zone with ground-lights at full perimeter of danger sector;
   Appoint, on danger zone limits, a site guard to forbid access, until public authorities take over.

SECTION 312100 - AGGREGATE SUBBASE COURSE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract and General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes aggregate for subbase course constructed on the prepared underlying course in accordance with the Specification and shall conform to the lines, grades, dimensions and typical cross section shown on the Drawings.

B. Related Sections include the following:

1. Division 31 Section 312000 “Earth Moving” for subgrade preparation, grading, and subbase course
2. Division 31 Section 312200 "Aggregate Base Course” for aggregate base course.
3. Division 32 Section 321216 “Asphalt Paving”.

1.3 DEFINITIONS

A. Aggregate Subbase Course: Subbase course composed of mineral aggregate uniformly blended and mixed with water.

B. Subgrade: Compacted soil layer immediately below the subbase course.

C. Subgrade Layer: 300 mm depth of soil material immediately below subgrade.

D. Lot of Compacted Material: 500 m² of compacted subbase course.

E. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Samples: For the following:

1. 100-kg samples, sealed in airtight containers, of each proposed aggregate material.

C. Design Mixes: Based on heavy truck loading as per AASHTO criteria, for subbase course mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1. Provide compressive strength test results and moisture-density curves.

D. Qualifications Data: For forms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and any other information required by Supervision Consultant.

E. Material Test Reports: Form a qualified independent testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of aggregate materials:

1. Classification according to AASHTO M 145.
2. Laboratory compaction curve according to AASHTO T180 (Method D).
3. Analysis of the results of testing as required by compaction and testing of earthworks.

F. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

G. Field Records for the Following:

1. Test Section
2. Verification of compliance of subgrade, in accordance with specified requirements, prior to placement of subbase course.
3. Laboratory reports; laboratory density test results for each lot.
4. Field reports; in - place density test results for each lot.

H. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by earthwork operations.

I. Minutes of preinstallation conference.

J. Daily Progress Reports: Include location of all construction joints.

K. Method statement : Prior to commencing any work, the Contractor shall submit a 'Method Statement' detailing how each item of work will be performed, including:

1. Leveling Plan.
2. Excavation Plan.
3. Filling Plan.
4. Methods of compaction and carrying out site grading.
5. Control of water and dewatering plan.
6. List of tools, equipment and transport trucks to be used.
7. Supervision and control system.

L. Quality control program.

M. Weekly and monthly quality control reports.

N. Survey measurements for tolerance control and payment purpose.

O. Program of execution, calculation volume of excavations, periodicity of trucks, and fleet of trucks needed for the completion of the works within the program limits.

P. Dumping area, relative permits and/or sub-agreements.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with the Provisions of AASHTO or ASTM circulars and standards, except where different requirements are specified or shown on the drawings.

B. Installer Qualifications: Engage an experienced installer who has completed aggregatesubbase course similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Manufacturer Qualifications: Engage a firm experienced in manufacturing similar to that indicated for this Project and with a record of successful in-service performance.

D. Surveyor Qualifications: An independent licensed surveyor, acceptable to the Supervision Consultant and experienced in ground surveys.

E. Testing Agency Qualifications: Demonstrate to Supervision Consultant's satisfaction, based on Engineer's evaluation of criteria, that the independent testing agency has the experience and capability to satisfactorily conduct the testing indicated in access with standards without delaying the Work.

F. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work.

G. Pre-installation Conference: Conduct conference at Project site to comply with General Requirements.

1.6 PROJECT CONDITIONS

A. Provide a minimum 48 hour notice to the Supervision Consultant, and receive written notice to proceed, before interrupting any service, facility or utility operated or occupied by the Employer or others.

B. Protect subbase coarse from rain, wind and sun, indentation and physical damage.

C. Finished portions of the subbase course that are used by equipment in the construction of an adjoining section shall be protected to prevent marring or damaging the completed work.

D. Project Site Information: The Contractor is entirely responsible for his own assessment, interpretation, use and conclusions drawn from the information, data, tests, analyses and opinions contained in any Site Investigation report discussed or related to the project conditions.

1. Whenever needed, additional test borings and other exploratory operations shall be conducted at the Contractor’s own cost and expense.

E. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earthwork operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from employers and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

F. Notify utilities companies and authorities having jurisdiction for area where Project is located before commencing earthwork operations.

G. Existing Utilities: Do not interrupt utilities serving facilities on or adjacent to Project site unless permitted in writing by Supervision Consultant and then only after arranging to provide temporary utility services according to requirements.

1. Include interruptions of utilities in the Contractor's Construction Schedule (CPM schedule) as milestones. Comply with requirements of Section 013200 (Construction Progress Documentation).

2. Coordinate interruptions of utilities with owner and authorities having jurisdiction in accordance with CPM schedule.

3. Do not proceed with utility interruptions without Supervision Consultant's written permission.

H. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 AGGREGATE

A. Materials arising from excavations are to be used in sub-base course aggregate if it complies with AASHTO soil classification A-2-6 (Silty or clayey gravel with sand) or the specified requirements unless instructed by the Supervision Consultant to be removed from the site.

B. Aggregate: Shall be sand, natural gravel, crushed stone or crushed gravel. The fine aggregate shall consist of screenings obtained from crushed stone, gravel, or sand.

C. Aggregate may be washed, if directed, to remove excessive quantities of clay, silty clay or salts.

D. Crushed Stone: Shall consist of hard, durable particles or fragments of stone, free from dirt or other objectionable matter, and shall contain not more than 8% of flat, elongated, soft, or disintegrated pieces.

E. Crushed Gravel: Shall consist of hard durable stones, rocks, and boulders crushed to specified sizes and shall be free from excess flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter.

F. The method used in production of crushed gravel shall be such that the finished product shall be as uniform as practicable. The crushing of the gravel shall result in a product, which shall have at least 90% by weight of particles with at least one fractured face. All stones, rocks, and boulders of inferior quality occurring in the pit shall be wasted.

G. Any material passing 4.75 mm (No. 4) sieve and produced in the crushing process shall be

incorporated in the subbase material up to the gradation limits required for the subbase course aggregate.

A. The Crushed Aggregate: Shall meet the requirements of the gradation shown in Table 1 when tested in accordance with AASHTO T-11 and T-27

TABLE 1: REQUIREMENTS FOR GRADATION OF AGGREGATE

Sieve Designation (Square openings)	Percent by weight passing
50 mm (2 in)	80 - 100
25 mm (1 in)	75 - 95
9.5 mm (3/8 in)	40 - 75
4.75 mm (No.4)	35 - 70
2.00 mm (No. 10)	20 - 45
0.425 mm (No.40)	15 - 30
0.075 mm (No.200)	0 - 10

H. The amount of the fraction of material passing the No. 200 mesh sieve shall not exceed one half the fractions passing the No. 40 mesh sieve.

I. The material shall contain a minimum sand equivalent value of 25% (Dry condition) when tested in accordance with AASHTO T 176.

J. The percentage of wear shall not exceed 40% after 500 revolutions, when tested in accordance with AASHTO T 96 (Los Angeles Abrasion Test).

K. The absorption should be not more than 10%.

L. The crushed aggregate subbase course material shall have a 4-day soaked CBR of not less than 40 when compacted at 100% of modified proctor AASHTO (T180) and tested in accordance with AASHTO T 193.

M. When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and the loss by weight after 5 cycles shall not exceed 12 % in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

N. The portion of aggregate, including any blended material, passing the 0.425 mm (No. 40) mesh sieve shall have a liquid limit (LL) of not more than 25 and plasticity index (PI) of not more than 6 when tested in accordance with AASHTO T 89 and T 90.

O. If additional fine material is required to correct the aggregate gradation, or for adjusting the LL or PI of the fraction passing the 0.425 mm (No. 40) sieve, it shall be uniformly blended and mixed with the aggregate material at the crushing plant or by an approved plant. Reworking of the material in situ to obtain the specified gradation will not be permitted. Additional fine material for these purposes shall be obtained from the crushing of stone, gravel, or natural material.

P. The crushed aggregate subbase course material shall have chloride content of less than 3.5 per cent and sulphate content of less than 2.0 per cent when tested in accordance with BS 812.

PART 3 - EXECUTION

3.1 OPERATION AT SOURCES OF SUPPLY

A. All work involved in clearing and grubbing of quarries and pits, including the handling of unsuitable material, shall be performed at own expense. The subbase material shall be obtained from approved sources. The material shall be handled in a manner that shall secure a uniform and satisfactory product.

3.2 EQUIPMENT

A. Equipment: Used to handle, place, spread, moisten, compact and finish subbase course shall be on the site in very good working condition, and approved by Supervision Consultant before construction is permitted to start.

3.3 SURFACE PREPARATION

A. Aggregate Subbase Course: Shall be placed directly on completed subgrade, preparation and the subgrade surface shall be as specified in section 312000.

3.4 TRIAL SECTIONS

A. Before commencement of Site sub-base construction, the Contractor may be required to lay and compact trial sections of varying thickness of sub-base. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site. Each trial section shall be laid using the same materials, mix proportions, mixing, spreading and compaction equipment, and construction procedures, proposed for use in the Works.

B. The objectives of these trials shall be to determine the adequacy of the Contractor's equipment, the loose depth measurements that will result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the sub-base material.

C. The Contractor shall not proceed with sub-base construction until the methods and procedures established in the trials have been approved.

D. The compaction trials shall involve all procedures specified for the permanent works including testing of any equipment, processes or procedures as proposed by the Contractor which are not included as a part of these specifications. Construction of the permanent works shall not commence until a rolling / compaction procedure has been approved in writing by the Supervision Consultant. Such approval shall in no way relieve the Contractor of his responsibilities and obligations stipulated in the Contract.

E. The compaction trials shall not be measured or paid for separately but shall be considered an incidental obligation of the Contractor under this Section of the Specifications.

3.5 MIXING AND SPREADING

A. The sub-grade shall be inspected and approved immediately prior to commencement of sub-base construction.

B. Subbase Course Material: May be premixed with water, in a pugmill mixing plant or on site. The amount of water added, as determined, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction.

C. The Supervision Consultant may allow other methods of mixing provided such methods(s) do not reduce the standard of work. Demonstrate, in the presence of Supervision Consultant, ability to attain the requirement given in this Specification.

D. Premixed Material: Shall be placed on the subgrade in a uniform layer not less than 75 mm nor more than 200 mm of compacted thickness.

E. The Contractor shall correct, at his own expense, any deviation from specified elevation and compaction in the surface to receive aggregate subbase.

F. Subbase course material shall be placed to the required width using a self-propelled spreader or motor grader, and shall be delivered such that it is ready for compaction without further shaping.

G. The material shall not be handled in such a way as to cause segregation. If the spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the spreader operation, the use of such spreader shall forthwith be discontinued and it shall be replaced by a spreader capable of spreading the material in a proper manner.

H. All segregated Material shall be removed and replaced with well graded material. "Skin" patching will not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances will be permitted during the compaction process.

I. Neither hauling nor placement of material will not be permitted when, in the judgement of Supervision Consultant, the weather or surface conditions are such that hauling operations will cause cutting or rutting of subgrade or cause contamination of the subbase course material.

3.6 COMPACTION

A. The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. If placing of succeeding layer of material is delayed to the extent that additional water is required to prevent raveling or excessive drying, the application of such water shall be carried out in an approved manner and at the Contractor’s expense.

B. The subbase Course Material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the centre, with each succeeding pass uniformly overlapping the previous pass.

C. Rolling shall continue until the entire thickness of each subbase layer is thoroughly and uniformly compacted to 100% AASHTO T 180 maximum density. The subbase shall be watered or dried as may be necessary to obtain moisture content suitable for compaction.

1. Density shall be measured in the field in accordance with AASHTO T 191 and determined in the laboratory in accordance with modified AASHTO T 180.
2. Final rolling of the completed course shall be by means of an approved self-propelled roller.
3. Rolling shall be accompanied by sufficient blading, to ensure a smooth surface, free from ruts or ridges and having the proper shape.
4. When additional water is required, it shall be applied in an approved manner.

5. The C.B.R. value of the subbase course after completion shall be not less than 40%.

D. Areas inaccessible to normal compaction shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved.

E. Each layer shall be completely compacted and approved prior to delivery of materials for the subsequent layer.

F. Prior to placing a subsequent layer, the surface shall be made sufficiently moist as directed, to ensure proper bond between the layers.

G. Edges and Edge Slopes of the Subbase Course shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the Drawings and to present straight, neat lines and slopes as free of loose material as practicable.

H. Material which has dried out prior to final compaction, or which has dried and decompacted subsequent to final compaction, shall be watered and recompacted using approved equipment and procedures. If unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, for the final layer only scarify the material and reconstruct the subbase course on a re-approved sub-grade surface.

3.7 TOLERANCES AND MAINTENANCE OF COMPLETED SUBBASE

A. The fully compacted and completed subbase course shall Conform to the lines, grades and cross sections as shown on the Drawings.

B. Elevations of the finished subbase course shall be checked in the presence of Supervision Consultant at intervals of 20m on straight lines and of 10m on curves, and at intermediate points as directed.

C. Tolerances (for final layer only) on elevations of finished surface shall not exceed + 10mm or -15mm. Minus tolerance shall be compensated by the proceeding layer.

D. When the finished surface is tested with a 4.0 m long straightedge, placed parallel to, or at right angles to the centreline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 12 mm.

E. All areas which exceed the specified tolerances shall be corrected by removing the defective sections of subbase course and reconstructing them or, if approved, by scarifying and adding new material and recompacting and finishing to the specified standard.

F. Following completion and acceptance of the subbase course, it shall be maintained by the Contractor at his own expense as follows:

G. The surface shall be broomed, rolled and otherwise maintained, keeping it free from ravelling and other defects until such time as the following course is placed.

H. Water shall be applied at such times and in such quantities as directed.

3.8 TESTING

A. Subbase course material shall be tested in accordance with Table 2 after mixing with water at the mixing plant or in-situ compaction and if satisfactory shall be approved for use. This approval

shall not be deemed to constitute acceptance of the subbase course for full payment purposes.

B. Compaction: Tested in accordance with AASHTO T 191 (Sand Cone Method), AASHTO T 205 (Rubber Balloon Method) or AASHTO T 238 (Nuclear Method). If there is a significant delay between the construction of any layer and the following layer, the Supervision Consultant may require the compaction of the lower layer to be reverified to ensure that it has not loosened due to traffic, passage of construction equipment, adverse weather conditions or otherwise.

B. TABLE 2: Required Tests and Minimum Repetition for Subbase Course Material:

(A) Source of Materials		(B) Control on Site (The Road)	
Required Tests (A)	Repetition Required fo all Test in (A)	Required Tests (B)	Repetition Required for all Tests in (B)
1. Gradation of Material	; JGP# O CVGIKCN# EJCPIGF# and/or as requested by Supervisi Consultant	1. Proctor	Every 500 linear meter and/or as requested by Supervision Consultant
2. Plasticity Index and liquid limit	Every 500 linear me and/or YJGP# O CVGI EJCPIGF	2. Gradation	WJGP# O CVGIKCN EJCPIGF# and/or as requested by Supervision Consultant
3. Abrasion		3. Plasticity Index and liquid limit	Every 500 linear meter and/or when materials changed
4. CBR		4. CBR	
5. Sand Equivalent		5. Sand Equivalent	
6. Percentage of fractured Particles		6. Abrasion	
7. Chloride content		7. Clay lumps & friable particles	
8. Sulphate content		8. Field Density	Every 500 m2
		9. Thickness	As requested by Supervision Consultant

3.9 PROTECTION

A. Do not perform work when the Supervision Consultant determines that weather or other conditions are such that construction operations will damage the finished work.

B. Do not haul over aggregate subbase without approval. Repair damages resulting from occasional routing of equipment over the work.

C. Following the completion of the aggregate subbase course, all maintenance work necessary to keep the subbase course in a condition satisfactory for further work shall be performed.

SECTION 312200 - AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract and General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes aggregate for base course constructed on the prepared underlying subbase course in accordance with the Specification and shall conform to the lines, grades, dimensions and typical cross section shown on the Drawings.

B. Related Sections include the following:

1. Division 31 Section 312100 "Aggregate Subbase" for aggregate subbase course
2. Division 32 Section 321216 "Bituminous Pavement".

1.3 DEFINITIONS

A. Subbase: Compacted soil layer immediately below the base course.

B. Subbase Layer: 200 mm depth of soil material immediately below base course.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Samples: For the following:

1. 100-kg samples, sealed in airtight containers, of each proposed aggregate material.

C. Design Mixes: Based on heavy truck loading as per AASHTO criteria, for base course mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1. Provide compressive strength test results and moisture-density curves.

D. Qualifications Data: For forms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and any other information required by Supervision Consultant.

E. Material Test Reports: Form a qualified independent testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of aggregate materials:

1. Classification according to AASHTO M 145.
2. Laboratory compaction curve according to AASHTO T180 (Method D).

3. Analysis of the results of testing as required by compaction and testing of earthworks.

F. F. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

G. Field Records for the following:

1. Test Section
2. Verification of compliance of subgrade or subbase, in accordance with specified requirements, prior to placement of base course.
3. Laboratory reports; laboratory density test results for each lot.
4. Field reports; in - place density test results for each lot.

H. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by earthwork operations.

I. Minutes of preinstallation conference.

J. Daily progress reports, to include location of all construction joints.

K. Method statement : Prior to commencing any work, the Contractor shall submit a 'Method Statement' detailing how each item of work will be performed, including:

1. Leveling Plan.
2. Excavation Plan.
3. Filling Plan.
4. Methods of compaction and carrying out site grading.
5. Control of water and dewatering plan.
6. List of tools, equipment and transport trucks to be used.
7. Supervision and control system.

L. Quality control program.

M. Weekly and monthly quality control reports.

N. Survey measurements for tolerance control and payment purpose.

O. Program of execution, calculation volume of excavations, periodicity of trucks, and fleet of trucks needed for the completion of the works within the program limits.

P. Dumping area, relative permits and/or sub-agreements.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with the Provisions of AASTO and ASTM circulars and standards, except where different requirements are specified or shown on the drawings.

B. Installer Qualifications: Engage an experienced installer who has completed aggregate base course similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Manufacturer Qualifications: Engage a firm experienced in manufacturing similar to that indicated for this Project and with a record of successful in-service performance.

D. Surveyor Qualifications: An independent licensed surveyor, acceptable to the Supervision Consultant and experienced in ground surveys.

E. Testing Agency Qualifications: Demonstrate to Supervision Consultant's satisfaction, based on Supervision Consultant's evaluation of criteria, that the independent testing agency has the experience and capability to satisfactorily conduct the testing indicated in access with standards without delaying the Work.

F. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work.

G. Pre-installation Conference: Conduct conference at Project site to comply with GeneralRequirements.

1.6 PROJECT CONDITIONS

A. Provide a minimum 48 hour notice to the Supervision Consultant, and receive written notice to proceed, before interrupting any service, facility or utility operated or occupied by the Employer or others.

B. Protect base course from rain, wind and sun, indentation and physical damage.

C. Finished portions of the base course that are used by equipment in the construction of an adjoining section shall be protected to prevent marring or damaging the completed work.

D. Project Site Information: The Contractor is entirely responsible for his own assessment, interpretation, use and conclusions drawn from the information, data, tests, analyses and opinions contained in any Site Investigation report discussed or related to the project conditions.

1. Whenever needed, additional test borings and other exploratory operations shall be conducted at the Contractor’s own cost and expense.

E. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earthwork operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from employers and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

F. Notify utilities companies and authorities having jurisdiction for area where Project is located before commencing earthwork operations.

G. Existing Utilities: Do not interrupt utilities serving facilities on or adjacent to Project site unless permitted in writing by Supervision Consultant and then only after arranging to provide temporary utility services according to requirements indicated:

1. Include interruptions of utilities in the Contractor’s Construction Schedule (CPM schedule) as milestones. Comply with requirements of Section 013200 (Construction Progress Documentation).

2. Coordinate interruptions of utilities with owner and authorities having jurisdiction in accordance with CPM schedule.

3. Do not proceed with utility interruptions without Supervision Consultant's written permission.

H. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 AGGREGATE

A. Materials arising from excavations are to be used in base course aggregate if it complies with the AASHTO soil classification (A-1-a and A-1-b) or specified requirements unless instructed by the Supervision Consultant to be removed from the site.

B. Aggregate: Shall be either crushed stone or crushed gravel. The fine aggregate shall consist of screenings obtained from crushed stone, gravel, or sand. Aggregate may be washed, if directed, to remove excessive quantities of clay, silty clay or salts.

C. Crushed Stone: Shall consist of hard, durable particles or fragments of stone, free from dirt or other objectionable matter, and shall contain not more than 8% of flat, elongated, soft, or disintegrated pieces.

D. Crushed Gravel: Shall consist of hard durable stones, rocks, and boulders crushed to specified sizes and shall be free from excess flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter.

E. The method used in production of crushed gravel shall be such that the finished product shall be as uniform as practicable. The crushing of the gravel shall result in a product, which shall have at least 90% by weight of particles with at least one fractured face. All stones, rocks, and boulders of inferior quality occurring in the pit shall be wasted.

F. Any material passing 4.75 mm (No. 4) sieve and produced in the crushing process shall be incorporated in the base material up to the gradation limits required for the base course aggregate.

G. Crushed Aggregate: Shall meet the requirements of one of the gradation shown in Table 1 when tested in accordance with AASHTO T-11 and T-27

TABLE 1: REQUIREMENTS FOR GRADATION OF AGGREGATE

Sieve Designation (Square openings)	Percent by weight passing
37 mm (1 ½ in)#	100
25 mm (1 in)	60 - 100
19 mm (¾ in)	55 - 85
9.5 mm (3/8 in)	40 - 70
4.75 mm (No.4)	30 - 50
0.60 mm (No.30)	12 - 30
0.075 mm (No.200)	3 -10

H. The material shall contain a minimum sand equivalent value of 45% (Dry condition) when tested in accordance with AASHTO T 176.

I. The amount of the fraction of material passing the No. 200 mesh sieve shall not exceed one half the fraction passing the No. 40 mesh sieve.

J. The percentage of wear shall not exceed 40% after 500 revolutions, when tested in accordance with AASHTO T 96 (Los Angeles Abrasion Test).

K. The absorption should be not more than 10%.

L. The crushed aggregate base course material shall have a 4-day soaked CBR of not less than 80 when compacted at 100% of modified proctor AASHTO (T180) and tested in accordance with AASHTO T 193.

M. When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and the loss by weight shall not exceed 12 % in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

N. The portion of aggregate, including any blended material, passing the 0.425 mm (No. 40) mesh sieve shall have a liquid limit (LL) of not more than 25 and plasticity index (PI) of not more than 6 when tested in accordance with AASHTO T 89 and T 90. The friable particles 0.25% maximum.

O. If additional fine material is required to correct the aggregate gradation, or for adjusting the LL or PI of the fraction passing the 0.425 mm (No. 40) sieve, it shall be uniformly blended and mixed with the aggregate material plant at the crushing plant or by an approved plant. Reworking of the material in situ to obtain the specified gradation will not be permitted. Additional fine material for these purposes shall be obtained from the crushing of stone, gravel, or natural material.

P. The crushed aggregate base course material shall have chloride content of less than 0.8 per cent and sulphate content of less than 0.50 per cent when tested in accordance with BS 812.

PART 3 - EXECUTION

3.1 OPERATION AT SOURCES OF SUPPLY

A. All work involved in clearing and grubbing of quarries and pits, including the handling of unsuitable material, shall be performed at own expense. The base material shall be obtained from approved sources. The material shall be handled in a manner that shall secure a uniform and satisfactory product.

3.2 EQUIPMENT

A. All equipment used to handle, place, spread, moisten, compact and finish base course shall be on the site in very good working condition, and approved by Supervision Consultant before construction is permitted to start.

3.3 SURFACE PREPARATION

A. Aggregate Base Course: Shall be placed directly on completed subbase. Preparation of the subbase surface shall be as specified in section 312100.

3.4 TRIAL SECTIONS

A. If the Supervision Consultant deems it necessary the Contractor shall lay and compact trial sections of varying thickness of base. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site. Each trial section shall be laid using the same materials, mix proportions, mixing, spreading and compaction equipment, and construction procedures, proposed for use in the Works.

B. The objectives of these trials shall be to determine the adequacy of the Contractor's equipment, the loose depth measurements that will result in the specified compacted layer depths, the field moisture content for compaction, and the relationship between the number of compaction passes and the resulting density of the base course material.

C. The Contractor shall not proceed with base course construction until the methods and procedures established in the trials have been approved.

D. The compaction trials shall involve all procedures specified for the permanent works including testing of any equipment, processes or procedures as proposed by the Contractor which are not included as a part of these specifications. Construction of the permanent works shall not commence until a rolling / compaction procedure has been approved in writing by the Supervision Consultant. Such approval shall in no way relieve the Contractor of his responsibilities and obligations stipulated in the Contract.

E. The compaction trials shall not be measured or paid for separately but shall be considered an incidental obligation of the Contractor under this Section of the Specifications.

3.5 MIXING AND SPREADING

A. Before placing the mixed materials the surface of the sub-base shall be prepared.

B. Base Course Material: May be premixed with water, in a pugmill mixing plant. The amount of water added, as determined, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction.

C. The Supervision Consultant may allow other methods of mixing provided such methods(s) do not reduce the standard of work. Demonstrate, in the presence of the Supervision Consultant, ability to attain the requirement given in this Specification.

D. Premixed material shall be placed on the sub-base in a uniform layer not less than 75 mm nor more than 200 mm of compacted thickness.

E. Base course material shall be placed to the required width using a self-propelled spreader or motor grader, and shall be delivered such that it is ready for compaction without further shaping.

F. The amount of water added, as approved by the Supervision Consultant, shall be such that the material will be uniform and within the specified moisture content optimum range at the time of compaction.

G. Material shall not be handled in such a way as to cause segregation. If the spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the spreader operation, the use of such spreader shall forthwith be discontinued and it shall be replaced by a spreader capable of spreading the material in a proper manner.

H. All segregated material shall be removed and replaced with well graded material. "Skin" patching will not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances will be permitted during the compaction process.

I. Hauling or placement of material will not be permitted when, in the judgment of the Supervision Consultant, the weather or surface conditions are such that hauling operations will cause cutting or rutting of subgrade or cause contamination of the base course material.

3.6 COMPACTION

A. The water content of material shall be maintained during the placing period. Such adjustment in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation of water, and to ensure a satisfactory base course

B. Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. If placing of succeeding layer of material in delayed to the extent that additional water is required to prevent ravelling or excessive drying, the application of such water shall be carried out in an approved manner and at the Contractor’s expense.

C. Base course material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the centre, with each succeeding pass uniformly overlapping the previous pass.

D. Rolling shall continue until the entire thickness of each base layer is thoroughly and uniformly compacted to 100% AASHTO T 180 maximum density.

1. Density shall be measured in the field in accordance with AASHTO T 191 and determined in the laboratory in accordance with modified AASHTO T 180.
2. Final rolling of the completed course shall be by means of an approved self-propelled roller.
3. Rolling shall be accompanied by sufficient blading, to ensure a smooth surface, free from ruts or ridges and having the proper shape.
4. When additional water is required, it shall be applied in an approved manner.
5. The C.B.R. value of the base course after completion shall be more than 80%.

E. Areas inaccessible to normal compaction equipment shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved, or to the satisfaction of Supervision Consultant.

F. Each layer shall be completely compacted and approved prior to delivery of materials for the following layer.

G. Prior to placing a following layer, the surface shall be made sufficiently moist as directed, to ensure proper bond between the layers.

H. Edges and edge slopes of the base course shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the Drawings and to present straight, neat lines and slopes as free of loose material as practicable.

I. Material which has dried out prior to final compaction, or which has dried and decompacted subsequent to final compaction, shall be watered and recompacted using approved equipment and procedures. If unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, for the final layer only scarify the material and reconstruct the base course on a re-approved subbase surface or to the satisfaction of Supervision

Consultant.

3.7 TOLERANCES AND MAINTENANCE OF COMPLETED BASE

A. The fully compacted and completed base course shall conform to the lines, grades and cross sections as shown on the Drawings.

B. Elevations of the finished base course shall be checked in the presence of the Supervision Consultant at intervals of 20m on straight lines and of 10m on curves, and at intermediate points as directed.

C. Tolerances (for final layeronly) on elevations of finished surface shall not exceed + 10mm or -15mm.

D. When the finished surface is tested with a 4.0 m long straightedge, placed parallel to, or at right angles to the centreline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 12 mm.

E. All areas which exceed the specified tolerances shall be corrected by removing the defective sections of base course and reconstructing them or, by scarifying and adding new material and recompacting and finishing to the specified standard.

F. Following completion and acceptance of the base course, it shall be maintained by the Contractor at his own expense as follows:

1. The surface shall be broomed, rolled and otherwise maintained, keeping it free from ravelling and other defects until such time as the following course is placed.
2. Water shall be applied at such times and in such quantities as directed.

G. The aggregate base needs to be mechanically swept and cleaned with compressed air before the application of prime coat.
The base shall be sealed with prime coat before it is dried out. If the surface has dried out then light watering and re-compaction may be done before applying prime coat. If full depth is dry, the whole base shall be removed and replaced.

3.8 TESTING

A. Base course material shall be tested in accordance with Table 2 after mixing with water at the mixing plant or in-situ compaction and if satisfactory shall be approved for use. This approval shall not be deemed to constitute acceptance of the base course for full payment purposes.

B. Compaction: Tested in accordance with AASHTO T 191 (Sand Cone Method), AASHTO T 205 (Rubber Balloon Method) or AASHTO T 238 (Nuclear Method). If there is a significant delay between the construction of any layer and the following layer, Supervision Consultant may require the compaction of the lower layer to be reverified to ensure that it has not loosened due to traffic, passage of construction equipment, adverse weather conditions or otherwise.

TABLE 2: Required Tests and Minimum Repetition for Base Course Material

(A) Source of Materials		**(B) Control on Site (The Road)**	
Required Tests (A)	**Repetition Required fo all Test in (A)**	**Required Tests (B)**	**Repetition Required for all Tests in (B)**

1. Gradation of Material	; JGP#D CVGIKCN#EJCPI and/or as requested by Supervision Consultant	1. Proctor	Every 500 linear meter and/or as requested by Supervision Consultant
2. Plasticity Index and liquid limit	Every 500 linear meter and/or YJGP#D CVGIKCN EJCPIGF	2. Gradation	WJGP#D CVGIKCN# EJCPIGF#and/or as requested by Supervision Consultant
3. Abrasion		3. Plasticity Index a liquid limit	Every 500 linear meterand/or whGP# O CVGIKCN#EJCPIGF
4. CBR		4. CBR	
5. Sand Equivalent		5. Sand Equivalent	
6. Percentage of fractured Particles		6. Abrasion	
7. Chloride content		7. Clay lumps &fria particles	
8. Sulphate content		8. Field Density	Every 500 m2
#	#	9. Thickness	As requested by Supervision Consultant

3.9 PROTECTION

A. Do not perform work when the Supervision Consultant determines that weather or other conditions are such that construction operations will damage the finished work.

B. Following the completion of the crushed aggregate base course, all maintenance work necessary to keep the base course in a condition satisfactory for further work shall be performed.

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract and General Requirements, apply to this Section.

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:

1. General Requirements for recording preexisting conditions and excavation support and protection system progress.
2. General Requirements for temporary utilities and support facilities.
3. Division 31 Section 312319 "Dewatering" for dewatering system for excavations.
4. Division 03 Section 033000 "Cast-in-Place Concrete" for reinforced, cast-in-place concrete.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Monitor vibrations, settlements, and movements.

1.4 SUBMITTALS

A. Shop Drawings: For excavation support and protection system.

B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Method Statement: Provide a detailed narrative describing means, methods and techniques to be adopted for construction and installation of special excavation support and protection systems. Include details of equipment and instrumentation to be used, quality control, testing and report

procedures, work program, and any other information required by the Supervision Consultant.

1. Include a contingency plan outlining procedures to be adopted if problems arise.

D. Qualification Data: For qualified land surveyor and professional engineer.

E. Other Informational Submittals:

1. Photographs or Videotape: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.

2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

Note locations and capping depth of wells and well points.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

- Geotechnical report.
- Existing utilities and subsurface conditions.
- Proposed excavations.
- Proposed equipment.
- Monitoring of excavation support and protection system.
- Working area location and stability.
- Coordination with waterproofing.
- Abandonment or removal of excavation support and protection system.

B. Professional Engineer Qualifications: A professional engineer who is experienced in providing engineering services for designing excavation support and protection systems that are similar to those indicated for this project in material, design, and extent.

1. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for the excavation support and protection system including drawings, testing program, test results interpretation, and comprehensive analysis that shows the system's compliance with specified requirements.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility:

1. Include interruptions of utilities in the Contractor's Construction Schedule as milestones. Comply with requirements of Section 013200 (Construction Progress Documentation).

2. Coordinate interruptions of utilities with owner and authorities having jurisdiction in accordance with schedule.

3. Do not proceed with interruption of utility without Supervision Consultant's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection as deemed necessary, at own cost and expense.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Supervision Consultant if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness as needed by the design and approved by the Supervision Consultant.

E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

F. Shotcrete is furnished under Division 03 Section "Shotcrete".

G. Reinforcing Bars: ASTM A 615/A 615M, Grade 420, deformed.

H. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during

excavation support and protection system operations.
1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SLURRY DIAPHRAGM WALLS

A. Install slurry diaphragm walls before starting bulk excavation. Install diaphragm wall in panels to the required length, depth and thickness, ensure vertical alignment and integrity of construction joints. Install waterstops, where indicated, at construction joints.

B. Accurately align exposed faces of sheet piling to vary not more than 25 mm from a horizontal line and not more than 1:100 out of vertical alignment.

C. Ensure that the base of the wall is clean from loose material prior to lowering the reinforcement and concreting. Ensure that the reinforcement is clean and that the spacers are of adequate dimensions. The method of concreting adopted must achieve an end result acceptable to the Supervision Consultant.

3.3 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 50 mm from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations secure to soldier piles.

3.4 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 1500 mm. Accurately align exposed faces of sheet piling to vary not more than 50 mm

from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 ANCHORS / TIEBACKS

A. Anchors/Tiebacks: Drill, install, grout, and tension anchors or tiebacks. Test load-carrying capacity of each anchor or tieback and replace and retest deficient anchors or tiebacks.

B. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain anchors or tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.6 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Supervision Consultant.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section 312000 "Earth Moving."
2. Repair or replace, as approved by Supervision Consultant, adjacent work damaged or displaced by removing excavation support and protection systems.

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract and General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Bituminous concrete binder, wearing and surface course.
3. Bituminous prime and tack coats.

B. Related Sections include the following:

1. Division 31 Section 312000 "Earth Moving" for Subgrade.
2. Division 31 Section 312100 “Aggregate Subbase Course” for subbase courses.
3. Division 31 Section 312200 “Aggregate Base Course” for base courses.

1.3 APPLICABLE CODES AND STANDARDS

A. AASHTO

1. M 145: Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
2. T 2: Sampling Aggregates.
3. T 11: Amount of Material Finer than 0.075mm Sieve in Aggregate.
4. T27: Sieve Analysis of Fine and Coarse Aggregates.
5. T 86: Investigating and Sampling Soils and Rock for Engineering Purposes.
6. T 87: Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test.
7. T 88: Particle Size Analysis of Soils.
8. T 89: Determining the Liquid Limit of Soils.
9. T 90: Determining the Plastic Limit and Plasticity Index of Soils.
10. T 93: Determining the Field Moisture Equivalent of Soils.
11. T 96: Resistance to Abrasion of Small Size coarse Aggregate by Use of the Los Angeles Test.
12. T 100: Specific Gravity of Soils.
13. T 104: Soundness of Aggregate by Use of Sodium or Magnesium Sulphate.
14. T 143: Sampling and Testing Calcium Chloride for Roads and Structural Applications.

15. T 176: Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent test.
16. T 180: Moisture-Density Relations of Soils using a 10 lb (4.54 kg) Hammer and 18" (475 mm) distance ofDrop.
17. T 191: Density of Soil In-Place by the Sand-Cone Method.
18. T 193: The California Bearing Ratio.
19. T 204: Density of Soil In-Place by the Drive Cylinder Method.
20. T 205: Density of Soil In-Place by the Rubber-Balloon Method.
21. T 217: Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester.
22. T 49: Penetratison of bituminous materials; Ductility of bituminous materials.
23. T 72: Say bolt viscosity
24. T 78: Distillation of cut-back asphaltic products.

1.4 SUBMITTALS

A. Product Data: For each product specified. Include technical data and tested physical and performance properties.

B. Detailed Design calculation based on heavy truck loading as per AASHTO criteria

C. Job-Mix Designs: For each job mix proposed for the Work.

D. Shop Drawings: good for construction, indicate pavement markings, lane separations, and defined parking spaces. Indicate dedicated handicapped spaces with international graphics symbol, where shown on Drawings.

E. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by Supervision Consultant.

F. Material Test Reports: From a qualified independent testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to AASHTO of each on-site and borrow soil material proposed for fill.
2. Relative compaction test results as well as all other laboratory test results submitted to the Supervision Consultant on a monthly basis.
3. Test results that represent average results for produced materials not over two (2) years old.

G. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

H. Samples: 14-kg samples, sealed in airtight containers, of each proposed soil material from on-site or borrow sources.

I. Method statement : Prior to commencing any work, the Contractor shall submit a 'Method Statement' detailing how each item of work will be performed, including:

1. Leveling Plan.

2. Methods of compaction and carrying out site grading.
3. Control of water and dewatering plan.
4. List of tools, equipment and transport trucks to be used.
5. Supervision and control system.
6. Speed bumps and studs installation.

J. Quality control program.

K. Weekly and monthly quality control reports.

L. Survey measurements for tolerance control and payment purpose.

M. Maintenance Data: Submit manufacturer’s recommended cleaning and maintenance data. Include maintenance procedures, recommended maintenance materials and suggested schedule for cleaning.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.

C. Testing Agency Qualifications: Demonstrate to Supervision Consultant's satisfaction, based on Supervision Consultant's evaluation of criteria, that the independent testing agency has the experience and capability to satisfactorily conduct the testing indicated in accordance with Standards, without delaying the Work.

D. Surveyor Qualifications: An independent licensed surveyor, acceptable to the Supervision Consultant and experienced in ground surveys

E. Regulatory Requirements: Paving works shall comply with AASHTO requirements.

F. Preinstallation Conference: Conduct conference at Project site to comply with

G. General Requirements to review methods and procedures related to asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
2. Review condition of substrate and preparatory work performed by other trades.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute the Work without delays.
5. Review inspection and testing requirements, governing regulations, and proposed installation procedures.

6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

C. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location and within temperature range required by manufacturer. Protect stored materials from direct sunlight.

C. Bitumen:

1. All transporting of bitumen shall be by conveyances that are free from contamination.
2. The Contractor shall provide an adequate storage facility for bitumen, at the site of the mixing plant. This facility should be clean and stable and provided with cover and shelter from excessive temperatures.
3. No open fires or smoking shall be allowed in or around the storage facility.
4. The storage capacity should be sufficient to maintain a uniform operation while allowing for delayed shipments and time for testing.
5. The stored bitumen products should be protected from temperatures which may exceed the range of -5°C to +60°C or as required according to flash point test as determined by AASHTO T 48.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp, if rain is imminent or expected before time required for adequate cure or during wet weather the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of 15 deg C.
2. Slurry Coat: Comply with weather limitations in ASTM D 3910.
3. Bituminous Binder Course: Minimum surface temperature of 15 deg C and rising at time of placement.
4. Bituminous Wearing Course: Minimum surface temperature of 15 deg C at time of placement and when the air temperature is at or above 5 deg C.

1.8 STOCKPILING

A. Stockpile areas shall be surveyed prior to stockpiling to establish control points and to obtain a record of existing cross sections for future use in determining stockpile quantities. The areas shall be adequately drained at all times. Stockpiles shall be segregated by source of material. Tests on each source of material shall be conducted separately, prior to the use of the material. No mixing of the different sources shall be performed unless prior approval of the Supervision Consultant has been obtained.

B. Stockpiling procedures shall not result in degradation or segregation of the stockpiled material, or introduction of foreign materials into the stockpile. Heights of aggregate stockpiles shall not exceed 5 m.

1.9 SAMPLING AND TESTING

D. The Contractor shall submit to the Supervision Consultant, 30 days prior to the scheduled beginning of crushing and screening operations, a statement of origin and composition of all aggregates proposed for use in the Works.

E. In order to ascertain the properties of aggregate materials, the Contractor shall submit for testing and approval, representative samples of all materials intended for incorporation in the Works, prior to starting quarry operations. The representative samples shall be taken by the Contractor in the presence of the Supervision Consultant.

F. Tests performed by the Contractor shall be utilized in assessing the locations, extent of deposits and quantities of materials which will conform to the Specifications when properly processed. Any special tests that may be required by the Supervision Consultant shall be carried out by the Contractor, in his own laboratory, or an outside laboratory, approved by the Supervision Consultant.

G. The Contractor may conduct necessary tests in the Field Laboratory in the presence of the Supervision Consultant.

H. Processed materials shall be tested and approved before being stockpiled on Site or incorporated in the Works and may be inspected and tested at any time by the Supervision Consultant during their preparation, storage and use.

I. Samples shall satisfy all specified test requirements. The Contractor shall permit the Supervision Consultant to inspect any and all materials used or to be used, at any time during or after their preparation, or while being used during progress of the Works. Unsatisfactory materials, whether in place or not, shall be removed promptly from the Site. The Contractor shall furnish all necessary materials, labor, tools and equipment and transport required by the Supervision Consultant for such inspections.

PART 2 - PRODUCTS

2.1 AGGREGATE

J. Aggregates for use in bituminous binder courses, wearing courses and surface course, shall consist of crushed stone or crushed aggregate, screenings and mineral filler, with or without sand meeting the specified gradation.

K. Coarse aggregate shall be the fraction of crushed aggregate material retained on 4.75 mm (No. 4) sieve. Fine aggregate in accordance to AASHTO M 29 shall be the fraction of crushed aggregate material passing 4.75 mm (No. 4) sieve. Mineral filler in accordance to AASHTO M 17 shall be added when the combined grading of coarse and fine aggregates is deficient in material passing 0.075 mm (No. 200) sieve.

L. The aggregates shall contain no more than 10% thin or elongated particles plus fine aggregates passing the 4.75 mm (No. 4) sieve.

M. Aggregates shall not contain gypsum more than 1% when tested in accordance to AASHTO T 105, and the coarse fraction of the aggregate shall not contain more than :

1. 5% chert and flint for aggregate to be used in the Wearing course.
2. 5% chert and flint for aggregate to be used in the Binder course.

N. Aggregates shall be of uniform quality, free from decomposed stone, organic matter, shale and any other deleterious substances.

O. The percentage by weight of friable particles, clay lumps, and other deleterious matter shall not exceed 1% as determined by AASHTO T 112.

P. Aggregate particles shall be clean, hard, durable and sound. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve, at least 90% by weight shall have 2 or more fractured faces.

Q. When tested for soundness in accordance with AASHTO T 104 the coarse aggregate (retained on No. 4 sieve) shall not show signs of disintegration and the loss by weight after 5 cycles shall not exceed 9% in the case of the sodium sulfate test and 12% in the case of the magnesium sulfate test.

R. The loss in weight of aggregate after 500 revolutions, when tested in accordance with AASHTO T 96 (Los Angeles Abrasion test), shall not exceed 30%.

S. Water absorption of the coarse aggregate as determined by BS 812 or ASTM C 128/C127 shall not exceed 2% by weight.

T. The flakiness index and the elongation index test should be conducted in accordance with BS 812 Part 105.1 and Part 105.2; the following are the maximum limits:

	Surface &Wearing Course	Binder Course
Flakiness Index F.I.	25	30
Elongation Index E.I.	25	30

U. Aggregates shall be washed if directed, to remove any clay lumps, organic matter, adherent dust or clay films or other extraneous or deleterious matter that may prevent or detract from proper adhesion of bitumen to the aggregate particles.

V. Mineral filler shall consist of finely divided mineral matter such as limestone dust if added separately; hydrated lime; other non-plastic mineral filler, free from clay and organic impurities; or Portland cement, conforming to AASHTO M 17.

W. Aggregates shall comply with the following:

1. Acid soluble chloride: BS 812 Part 117 0.1 % max
2. Acid soluble sulphate: BS 812 Part 118 0.5 % max

X. Combined coarse and fine aggregates for bituminous mixes, including mineral filler, when tested in accordance with AASHTO T 27 and T 11, shall conform to the following requirements:

Heavy Traffic		
Sieve Designation	***Binder*** Course	***Wearing*** Course
1 1/2"	---	---
25.0 mm (1")	100	100
19.0 mm (3/4")	80 – 100	86 – 100
12.5 mm (1/2")	63 – 85	69 – 87
9.5 mm (3/8")	57 – 77	58 – 78
4.75 mm (No. 4)	40 – 60	40 – 60
2.36 mm (No. 8)	25 – 45	25 – 45
1.18 mm (No. 20)	13 – 27	13 – 27
0.300 mm (No. 50)	5 – 17	5 – 17
0.150 mm (No. 80)	4 – 14	4 – 14
0.075 mm (No. 200)	*2 – 8*	*2 – 8*

Y. The material from hot bins passing the number 40 sieve (0.425 mm) when tested in accordance with AASHTO T 90 shall be non plastic. In addition the material from cold bins should not have PI larger than 5.

Z. When tested for resistance to stripping in accordance with the AASHTO T-182 at least 95% coated particles should be achieved. Scandinavian test shall be carried out and at least 60% of the coarse aggregate surface area shall remain coated with a bitumen film especially for exposed surfaces otherwise anti stripping agent must be added to achieve the required coating.

AA. When necessary to improve the coating of aggregate by bitumen, additives of approved type will be added to the bituminous material in such percentage as required to obtain satisfactory results in the affinity, with bitumen test performed in accordance to AASHTO T 182. The approved additive will be used in accordance with Technical Specifications issued by the manufacturer and approved by the Supervision Consultant after appropriate testing.

BB. No Extra payment will be made for required anti-stripping additives.

CC. Material shall pass test according to AASHTO T283 “Resistance of Asphalt Concrete Mixtures to Moisture-Induced Damage”.

DD. The hot bin materials shall contain a minimum 70 % sand equivalent (AASHTO T 176). Test sample shall be taken from hot bins.

EE. The Aggregate crushing value should be conducted in accordance with BS 812 part 110; the following are the maximum limits:

	Wearing Course	Binder Course
Crushing value	20%	25%

FF. For hot-mix asphalt, limit natural sand to a maximum of 10 percent by weight of the total aggregate mass.

2.2 BITUMEN MATERIALS

A. Bitumen binder penetration shall be grade 60-70 unless otherwise specified.

B. Heating of Bitumen

1. Heating equipment shall be of an approved type. Any method of agitation or heating that introduces free steam or moisture into the bitumen will not be approved.
2. Tanks for heating and storage of bitumen shall be capable of heating the material, under effective and positive control at all times, to the specified temperature. The system shall provide uniform heating for the entire contents of the tank.
3. Thermometers of approved type and adequate range (calibrated in 2 degrees C increments) for accurately measuring the temperature of the bitumen while heating, shall be located so as to be readily visible and shall be kept clean and in proper working order at all times.

C. Sampling and Testing

1. Procedures for sampling of bituminous materials shall conform to AASHTO T 40.

D. Penetration Graded Bitumen

1. Wherever specified, the various grades of penetration graded bitumen Asphalt cement shall conform generally to the requirements of AASHTO M 20.
2. If its required by the Supervision Consultant to use viscosity graded asphalt cement it shall meet the requirement of AASHTO M 226-80 table 1,2.
3. Sampling and testing shall be in accordance with the AASHTO standard method listed in AASHTO M 20.
4. Penetration bitumen application temperature range shall be so that appropriate viscosity range for each application is achieved. Application temperature shall range between 145^{o} C and 165 ^{o} C for bitumen grade 60-70.
5. An approved modifier shall be incorporated in all penetration graded bitumens whenever specified immediately prior to the time of use, unless otherwise shown on the Drawings.

E. Rapid-Curing (RC) Cutback Bitumen

1. RC cutback shall conform to the requirements of AASHTO M 81.
2. Sampling and testing shall be in accordance with the AASHTO standard methods listed in AASHTO M 81.
3. RC cutback bitumen spraying temperature ranges shall be so that appropriate viscosity for each application is achieved, if however the viscosity curve are not available the values given below should be generally consider as guidance :

	RC Cutback Grade	Spraying Temp. ^{o}C
2.	RC – 70	40 – 75

F. Medium-Curing (MC) Cutback Bitumen

1. MC cutback shall conform to the requirements of AASHTO M 82.
2. Sampling and testing shall be in accordance with the AASHTO standard methods listed in AASHTO M 82.
3. MC cutback bitumen spraying temperature ranges shall be so that appropriate viscosity for each application is achieved, if however the viscosity curve are not available the values given below should be generally consider as guidance :

3.	MC Cutback Grade	Spraying Temp. o C
4.	MC – 30	21 – 63
5.	MC – 70	45 – 80

G. Emulsified Bitumens

1. Selection and use of emulsified bitumens shall generally be in accordance with the recommendations in AASHTO R 5.

H. Anionic Emulsified Bitumen

1. Anionic emulsified bitumens shall, prior to dilution, conform to the requirements of AASHTO M 140, for Type SS-1 and SS-1h.
2. Sampling and testing shall be in accordance with AASHTO T 59.
3. Emulsified bitumen spraying temperature range shall be so that appropriate viscosity for each application is achieved, if however the viscosity curves are not available these values should be generally as guidance 25 - 65 degrees C.

I. Cationic Emulsified Bitumen

1. Cationic emulsified bitumens shall, prior to dilution, conform to the requirements of AASHTO M 208, for Types CSS-1.
2. Sampling and testing shall be in accordance with AASHTO T 59.
3. Emulsified bitumen spraying temperature range shall be so that appropriate viscosity for each application is achieved, if however the viscosity Curve are not available, these values should be generally as guidance 25-65 degrees C.

2.3 PRIME COATS

A. Prime coats shall be medium-curing cutback asphalt, MC-30 (MC-0) or MC-70 (MC-1) as recommended by ASTM D2399-83 for open and tight surfaces.

2.4 TACK COATS

A. The Tack coat material shall be either rapid curing cutback asphalt RC-70 (RC-1) or slow setting emulsified asphalt SS-1, SS-1h, CSS-1, or CSS-1h.

2.5 WATER

A. Potable.

2.6 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wettable powder form.

B. Sand: AASHTO M 29 or ASTM D 1073, Grade Nos. 2 or 3.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that base courseis dry and in suitable condition to support paving and imposed loads.

B. Proof-roll the aggregate base course using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Inspect surfaces on which asphalt materials are to be placed for conformance to the required compaction, grades, and sections.

D. Notify Supervision Consultant in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.2 COLD MILLING

A. Clean existing paving surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement, including hot-mix asphalt and, as necessary, unbound-aggregate base course, by cold milling to grades and cross sections indicated.

3.3 PATCHING AND REPAIRS

A. All saw-cutting and breaking of existing pavements of any type, cleaning, patching, sealing or carrying out pavement repair works shall be coordinated with the Supervision Consultant through the submission of detailed method statement for every area that needs repair. The method statement should show the extent of patching or repair works, the steps that shall be followed and the materials that shall be used for each type of repair, with due consideration to the applicability of the proposed method and materials to each specific repair case. The execution shall not start before receiving the written approval of the Supervision Consultant.

B. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 300 mm into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

1. Tack coat faces of excavation and allow to cure before paving.
2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

C. Leveling Course: Install and compact leveling course consisting of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 25 mm in existing pavements.
1. Install leveling wedges in compacted lifts not exceeding 75 mm thick.

D. D. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of 6 mm. Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.

1. Tack Coat: Apply according to Article 3.6.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

C. Remove loose materials from existing asphalt pavement and clean surface using approved mechanical sweepers, blowers, and hand brooms. Remove loose broken, or shattered asphaltic material along the edges of existing surfaces. Shape, blade, and broom the exposed subgrade and a sufficient width of shoulder to provide a uniform firm subgrade for the new surface course.

D. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application Control of Traffic: Do not permit unnecessary traffic on the surface after it has been approved to receive asphaltic material instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat when formulated by manufacturer for that purpose.

E. Control of Traffic: Do not permit unnecessary traffic on the surface after it has been approved to receive asphaltic material.

3.5 EQUIPMENT FOR SPREADING ASPHALTIC MATERIALS

A. All equipment used for surface cleaning, heating bitumen (if required) and application of prime and tack coats, shall be adequate for the purposes intended and shall be approved before use.

B. Equipment used for diluting emulsified bitumen, heating cutback bitumen, spraying cutback and emulsified bitumen, application of blotting material to prime coats, and for spreading asphaltic materials shall be approved by the Supervision Consultant.

3.6 PRIME AND TACK COATS

A. The equipment used for Prime and Tack Coats shall include:

1. Power broom or a power blower or both.
2. Pressure distributor.
3. Bitumeter having a dial registering travels per minute.
4. Pump equipped with tachometer having a dial registering liters per minute passing through the nozzles.
5. Indicator, indicating accurately the temperature of the asphaltic material.
6. Spray for not less than 3.00m width, with provision for application of lesser width when necessary.
7. Hose and spray nozzles attachment for applying materials to patches and inaccessible areas.
8. The distributor shall be provided with heating attachments and the asphaltic material shall be circulated during the entire process.

B. Construction of Trial Sections

1. The Supervision Consultant may, if he deems necessary, require trial sections to be constructed prior to the commencement of on Site prime or tack coat applications. The Contractor shall construct trial sections using varying application rates of bitumen, as selected by the Supervision Consultant. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site.

2. Each trial section shall be constructed using the same materials, mixing and spraying equipment, and construction procedures, proposed for use in the Works.

3. The objectives of these trials shall be to determine the adequacy of the Contractor's equipment and the most suitable application rates for cutback bitumen prime and tack coats.

4. The Contractor shall not proceed with any site coat applications until the methods and procedures established in the trials have been approved.

C. Prime and Tack Coats Application - General

1. All surfaces to receive prime or tack coats shall conform to the specified tolerances and compaction requirements and shall be properly cleaned using power brooms or power blowers. The surfaces shall be approved before applying any bitumen material.

2. The surfaces of all structures, curbs, gutters and other highway appurtenances shall be protected in an approved manner to prevent them from being splattered or stained with bitumen or damaged during equipment operation.

3. Application of prime coats and tack coats shall be performed only when the surface to be treated is sufficiently dry, for tack coat and sufficiently moist for prime coat, and when the atmospheric temperature is above 10°C for the application of tack coat, 15°C for the application of prime coat. There should be no fog, rain, strong winds, dusty conditions, or dust storms

4. The prime coat shall be applied only when the base meets the specified density requirements and the moisture content in the top half of the base does not exceed 90% of the optimum moisture of the base material.

5. The Contractor shall maintain prime coats and tack coats intact until they are covered by the subsequent pavement course.

D. Prime Coat Application

1. Application rates for prime coat will be determined by the Supervision Consultant from the trial sections, and shall be generally within the following ranges:

6.	Type of Surface	ltr/sq.m
7.	Shoulders and base	
8.	Courses	0.5 – 1.75
9.	Other surfaces	(determined from field tests or trials)

10. The surface of base course shall be lightly bladed and rolled prior to the application of prime coat. Prime coat shall be applied only when the surface is dry. A minimum period of 24 hours shall be allowed for the absorption and curing of the prime coat. The prime coat shall be applied at the rate specified above or as directed.

2. The Supervision Consultant may order additional trial sections and/or alter the previously established rates of application during progress of the Works.

3. If the moisture content of the base is too low, it shall be lightly sprinkled with water and rolled with a traffic roller before application of the primer.

4. Prime coat (MC-70) cutback, or other grade if ordered by the Supervision Consultant, shall be applied at the rate selected by the Supervision Consultant, using approved type pressure distributors operated by skilled workmen. The spray nozzles and spray bar shall be adjusted and frequently checked so that uniform distribution is ensured. Spraying shall cease immediately upon any clogging or interference of any nozzle, and corrective measures taken before spraying is resumed.
5. Hand spraying will be approved only for priming small patches or inaccessible areas that cannot be primed by normal operation of the pressure distributor.
6. Application of prime at the junction of spreads shall not be excessive. Any excess shall be removed from the surface and any skipped areas or recognized deficiencies shall be corrected by use of hand sprays.
7. Prime coats shall be cured for 3 days before traffic is allowed on it or before the succeeding pavement layer is placed, or as directed by the Supervision Consultant.
8. If the asphalt primer has not been completely absorbed by the base twenty-four (24) hours after application, just sufficient sand shall be spread over the surface with a mechanical spreader to blot up the excess asphalt and prevent it from being picked up by traffic. Prior to placing an intermediate or surface course, all loose sand shall be swept from the base. A hand spray shall be used to apply primer material necessary to touch up all spots unavoidably missed by the distributor

E. Tack Coat Application

1. Emulsified bitumen shall be diluted and thoroughly mixed with an equal amount of water before application.
2. The rate of application shall be approved by the Supervision Consultant and after trial tests are carried out it shall be between 0.1 and 0.6 kg/sqm., depending on whether RC cutback or emulsified bitumen is used and the surface condition of the bituminous course on which the tack coat is to be sprayed. The Supervision Consultant may alter the previously established rates of application during progress of the Works, if he deems it necessary.
3. Apply by approved pressure distributors. Spray nozzles and spray bar shall be adjusted and frequently checked to ensure uniform distribution. Stop spraying upon clogging or interference of any nozzles, and take corrective measures before resuming..
4. The tack coat shall be allowed to dry only until it is in a suitable tacky condition to receive the superimposed bituminous course. Tack coat application shall not proceed so far in advance of the following course that it dries out completely.
5. Application at the junction of spreads shall not be in excess of the specified amount. Squeegee excess from the surface and correct skipped and deficient areas by means of approved hand sprayers.
6. When approved, after the material has been applied for 48 hours and has not dried sufficiently, apply a light application of sand as blotter material. Apply blotting material sparingly and only on areas that have not dried.
7. Spraying procedures shall be as specified for prime coat application.
8. Tack coat shall be applied between the two layers of binder and first wearing course and between the first and second layer of wearing course at the rate specified in subparagraph 2 or as directed.

3.7 BITUMINOUS COURSES

A. Job Mix and Project Mix

1. No Bituminous mixture shall be manufactured until a job-mix formula based on the results of preliminary lab tests has been submitted by the Contractor and approved in writing by the Supervision Consultant. The formula shall indicate the exact proportion of bituminous material and the mix temperature..
2. The Job Mix Formula shall specify a combination of mineral aggregates including filler and bitumen (plus bitumen modifier if any) in such proportions as to produce a Job Mix which is within the limits of the specified gradation and bitumen-content ranges and which meets the Marshall test requirements.
3. The Marshall Test procedure shall be used to determine the percentage of bitumen to be incorporated in the mix. The Job Mix Formula shall take into consideration the absorption of bitumen into the aggregates. Air voids shall be calculated in accordance with the procedure given in the Asphalt Institute Manual, MS-2.
4. In order to meet the requirements, an approved additive such as Portland cement, hydrated lime or liquid anti-strip agent, may be required in the Job Mix. Portland cement shall meet the requirements of AASHTO M 85. Hydrated lime shall meet the requirements of ASTM C 207, Type N. Cement or hydrated lime will normally be required in the approximate range of 2-3% by weight of the aggregates and shall be added at the cold feed in dry or slurry form as directed. Liquid anti-striping agent, if needed, will normally be required in the approximate range of 0.6-1.0% by weight of the bitumen, or according to the manufacturers' specifications.
5. The following composition limits by weight are to be applied:

11. *Total Aggregates* *96 – 93 %*

12. *Asphaltic Binder* *4 – 7%*

6. The Job Mix for bituminous binder and wearing courses shall conform to the following composition limits, as shown in Table below:

13. Property	Heavy Traffic	
14. Binder	Wearing	
15. 1- Marshall Stability		
16. Minimum at 60 C (Kg)	900	1000
17. 2-Flows (mms)	2-3.5	2-3.5
18. 3- Voids in Mineral		
19. Aggregate (VMA)	13 (-1)	14 (-1)
20. 4- Air Voids (%)	4-7	4-6
21. 5- Stiffness (Kg/mm)	500 (Min)	500 (Min)
22. 6-* Loss of Stability (%)	25 (Max)	25 (Max)
23. 7-% Aggregate voids		
24. Filled (VFA)	65% – 72%	75% – 82%
25. 8- Filler / Bitumen ratio	0.6-1.5	0.6-1.5

26. * This test to be carried out in accordance with AASHTO T 165-82.

7. Upon receipt of approval of the Job Mix Formula, the Contractor shall adjust his mixing plant to proportion the individual aggregates, mineral filler and bitumen to produce a final project mix within the limits given in table below with respect to the Job Mix gradations:

27. Maximum variation of Project Mix from Approved Job Mix

Sieve Designation (Square openings)	Specified Tolerances
9.5mm (3/8 in.) and above	+ or – 7.0%
4.75mm (No. 4)	+ or – 5.0%
2.36mm (No. 8)	+ or – 4.0%
1.18mm (No. 16)	+ or – 4.0%
0.600mm (No. 30)	+ or – 4.0%
0.300mm (No. 50)	+ or – 4.0%
0.150mm (No. 100)	+ or – 4.0%
0.075mm (No. 200)	+ or – 2.0%
Bitumen Content	+ or – 0.3%
Temperature of Mix on discharge	+ or – 11° C of the specified mixing temperature

8. Any deviation from these limits shall be made only with the approval of the Supervision Consultant.

9. Conformance to gradation requirements will be determined on the extracted aggregate in accordance with AASHTO T 30. The bitumen content shall be determined in accordance with AASHTO T 164.

10. The percentage of Bitumen needed for job mix must vary between:

    4% – 6.5% (For binder course).

    5% – 6.5% (For wearing course) by weight in relation to total weight of aggregates

11. The Supervision Consultant will test the project mix at least twice daily during plant operation and, if necessary, direct the Contractor to readjust the plant to conform to the Job Mix Formula. If, due to differing cold feed or hot bin gradations, the Contractor cannot consistently produce a project mix meeting 'the Job Mix requirements, production shall cease, the Job Mix shall be redesigned and re-approved and the plant readjusted to produce a new Job Mix.

B. Mixing Plant

1. Bituminous mixes shall be produced in an approved type batch mixing plant of adequate size. The plant shall conform to the relevant requirements of AASHTO M 156.

2. The mixing plant shall be fully equipped to control the gradation of hot dry aggregates and of cold damp aggregates.

3. The Contractor shall systematically inspect and verify, in the presence of the Supervision Consultant, on a weekly basis and also whenever suspected, the following key operational aspects of the mixing plant:

   State of repair of the screens, and their frame mountings.

   Proper working of cold and hot bin gates.

   Accuracy of batching scales for filler, aggregates and bitumen.

   Proper working of the nozzles of the mixer bitumen sprayer.

   State of repair of the paddle tips and liners of the mixer.

   Thermometers in working conditions.

4. At the commencement of the Contract at least one copy of the ASTM and AASHTO (applicable copies) latest edition.

C. Spreading and Finishing Equipments

1. Bituminous courses shall be spread and finished using approved type, self-contained, power-propelled pavers of sufficient capacity.

2. The Contractor shall make available, for reference by the Supervision Consultant, the manufacturer's instruction and operating manuals for each paver intended for use.

D. Construction of Trial Sections

1. Immediately prior to finalization of the Job Mix Formula, the Contractor shall lay trial sections of the various bituminous mixes intended for use in the Works. Each trial section shall be 2 lanes widths wide (operating simultaneously), with a longitudinal cold join, by 50 m long at approved locations on or closeto the Site. The trial section shall be of the same depth as the course which it represents. Each trial section shall be laid using the same materials, proposed Job Mix, mixing, spreading and compaction plant and spreading and compaction procedures, proposed for use in the Works.

2. Each trial section shall serve as a field verification of the Job Mix design. The mix density achievable and the air voids at that density shall be determined and, if less than required, the Job Mix Formula shall be adjusted accordingly.

3. Each trial section shall also demonstrate the adequacy of hauling, spreading and compaction equipment and the suitability of the construction methods and organization proposed.

4. The equipment used in construction of the trial section shall be the same equipment to be used on the remainder of the course represented by the trial section

5. One random sample shall be taken at the plant, triplicate specimens compacted, and tested for stability, flow, and laboratory air voids. A portion of the same sample shall be tested for theoretical maximum density, aggregate gradation and asphalt content. Four randomly selected cores shall be taken from the finished pavement mat, and four from the longitudinal joint, and tested for density. Random sampling shall be in accordance with procedures contained in AASHTO T 40. The test results shall conform to all specified requirements for work to continue. If all test results meet the specified requirements, the trial section shall remain as part of the project pavement. If test results exceed the specified tolerances, the test section shall be removed and replaced at no cost to the project and another test section shall be constructed..

6. If the initial trial section should prove to be unacceptable, the necessary adjustments to the Job Mix Formula, plant operation, placing procedures, and/or rolling procedures shall be made. A second trial section shall then be placed. Additional trial sections, as required, shall be constructed and evaluated for conformance to the specifications. Full production shall not begin until an acceptable section has been constructed and accepted.

E. Mixing Procedure

1. Each aggregate ingredient shall be heated and dried such that the temperature recorded in the hot fines bin after screening shall not exceed 170 degrees C. All material heated to more than 204 deg C in storage tanks shall be rejected.

2. Immediately after heating, the aggregates shall be screened into at least 3 sizes and conveyed into separate bins ready for batching and mixing with the bitumen. Screening operations shall produce, at plant operating capacity, gradations in each of the sizes of heated and dried aggregates that are reasonably uniform and will result in the production of a mix conforming to the Job Mix requirements.

3. The dried and heated aggregate and (cold) mineral filler shall be combined in the plant in the proportionate amounts as determined by the Job Mix. Just prior to bitumen entering the mixer, bitumen modifier (catalyst) or anti-stripping additive, if required, shall be thoroughly mixed with the bitumen which shall then be introduced into the pug-mill mixer in the proportionate amount determined by the Job Mix.

4. The temperature of the bitumen upon entering the pug-mill shall be within 15°C of the aggregate temperature. Unless otherwise directed, the bitumen temperature shall be as follows:

Type and Grade of Asphalt	**Viscosity (centistokes)**	**Max. Temperature ºC Immediately after discharge from Pug-mill**
85 – 100 penetration	170 + or - 20	160
60 – 70 penetration	170 + or - 20	163
40 – 50 penetration	170 + or - 20	163

5. Any mix subjected to higher temperature than those shown above shall be rejected.

6. The mixing time required in order to obtain a homogeneous mix and adequate coating of the aggregates with bitumen shall be determined by the Contractor in the presence of the Supervision Consultant. This time shall be determined whenever the source of aggregate for the mix changes.

7. In batch plants, mixing time shall begin upon entry of bitumen into the pug-mill.

F. Surface Preparation

1. Prior to placing of mixture, the surface of primed granular base course shall be cleaned of all loose dirt and other objectionable materials with a power broom..

G. Spreading and Finishing

1. The Contractor shall survey the centerline profile and crown of the existing surface or base and determine a reference grade line which will be submitted for approval.

2. Bituminous mixes shall be laid only when the air temperature is at least 5 degrees C or above when the existing surface is free from moisture, and when the weather is not foggy, rainy, dusty or excessively windy (particularly at low temperatures).

3. After completion of surface preparation, the bituminous mix shall be spread and finished true to crown and grade by approved automatically controlled bituminous pavers with string line and sensors used for accurate levelling and manually controlled paver or hand methods may be used on irregular or other sections when approved.

4. The bituminous concrete pavement shall be constructed in accordance with required thickness. Any pavement to be constructed over 80mm in thickness shall be laid in two or more courses or layers, and no one course or layer shall exceed eighty millimetres in thickness.

5. The mixture shall be placed in consecutive, adjacent strips with a minimum width of 3 m except where edge lanes require strips of lesser width. Placing shall begin along the centre line of crowned sections or on the high side of areas with a one-way slope.

6. Make surface test to check conformity with the specified crown and grade immediately after initial compression. Correct all variations by the removal or addition of materials and by continuous rolling. The finished surface shall not vary by more than the specified tolerances. After the completion of final rolling, retest the smoothness of the course. Immediately correct all humps and depressions exceeding the specified tolerances, as approved. Replace and recompact the pavement where holes are made for test purposes

H. JOINTS

1. Make joints so as to ensure thorough and continuous bond. Construct transverse construction joints in previously laid material by cutting the material back vertically for its full depth so as to expose a fresh surface. Transverse joints in one layer shall be offset by at least 600 mm from transverse joints in the previous layer. Transverse joints in adjacent lanes shall be offset a minimum of 2 m.

2. Offset longitudinal joints in successive layers not less than 300 mm.

3. Before placing the fresh mixture against a cut joint or against old pavement, spray or paint the contact surface with a thin uniform coat of liquid asphalt. Where a finishing machine is used, make the longitudinal joint by overlapping the screed on the previously laid material for a minimum width of 25 mm and depositing a sufficient amount of material so that the joint formed will be smooth and tight.

I. COMPACTION

1. Rollers shall be operated by competent and experienced operators in accordance with the manufacturer's instructions. Rollers shall be kept in operation continuously if necessary, so that all parts of the pavement receive substantially equal compaction at the time desired.

2. After spreading and strike-off, and as soon as the mix conditions permit, the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted, using approved types,sizes and numbers of rollers. Rolling shall not be prolonged to the point, where cracks appear or shoving or displacement occurs.

3. All rollers shall be self-propelled vibratory steel wheel, 2-axle tandem steel-tired and pneumatic-tired types, in proper operating condition, capable of reversing without backlash or tearing of the surface, and shall be operated at speeds slow enough to avoid displacement of the bituminous mix.

4. Rolling shall begin as soon as the bituminous concrete will bear the roller without undue displacement.

5. The speed of the rollers, rolling pattern and, in the case of vibrator rollers, the frequency and amplitude of vibration, shall be approved by the Supervision Consultant. To prevent adhesion of the mix to the rollers, the wheels shall be kept properly and lightly moistened with water. An excessive use of water will not be permitted.

6. The rolling pattern, type and number of rollers shall be established by site trial so as to achieve the required compaction. The approved rolling pattern shall be followed.

7. The roller shall not be permitted to stand on pavements that have not been fully compacted. Necessary precautions shall be taken to prevent the dropping of oil, grease, petrol, or other foreign matter on the pavement, either when rollers are in operation or standing.

8. The compacted density shall be equal to or greater than 98% for binder course and wearing course, respectively, of the average Marshall bulk specific gravity for each day's production unless otherwise directed by the Supervision Consultant.

9. Any mix that becomes loose, broken, mixed with foreign material, or which is in any way defective in finish or density, or which does not conform in all otherrespects with the specified requirements shall be removed, replaced with suitable material and properly finished.
10. Immediately after the completion of initial rolling by the steel rollers, pneumatic-typed rolling shall begin and continue until three complete coverages are obtained. The rollers shall be self-propelled; all tyres inflated to the same pressure and shall be operated on each coverage so that each succeeding trip of the roller will overlap slightly the coverage of the preceding trip.
11. The pneumatic rollers shall be operated at a maximum speed of eight 8Km/h.
12. After complete rolling has been done and after the bituminous materials has cooled and set sufficiently to hold the cover material, preferably not earlier than the day following the application of the material, the excess loose cover material along the edges shall be broomed and bladed off the shoulder to provide a distinct line along the edge of the surface.
13. Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
14. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
15. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked..

J. CONTACT SURFACES

1. Paint contact surfaces of concrete structures with a thin uniform coating of approved asphaltic material. Place asphaltic concrete uniformly high near contact surfaces so that after compaction it shall be 6 mm above the edge of such structures.

K. SAMPLING AND TESTING

1. For verification of material, moisture content, compaction, thickness etc…, the Supervision Consultant shall at all times have access to all portions of the Works and Sites. All sampling and testing of material and work shall be carried out under the direction of the Supervision Consultant.
2. Each Bitumen shipment must be accompanied by manufacturer's specifications and certificate of test results. The Supervision Consultant can, however, order check tests at any time, if considered necessary. For each bitumen shipment, penetration and softening point test shall be performed.

- Flash point	AASHTO T48
- Penetration	AASHTO T49
- Softening Point	AASHTO T53

3. The Marshall Bulk specific gravity shall be determined in accordance with AASHTO T 166 or AASHTO T 275.
4. Resistance to Plastic Flow of Bituminous Mixture shall be determined in accordance with AASHTO T 245.
5. Loss of stability should be tested at least once every 3 working days. The result should not exceed 25% losses from the original stability.

6. Any testing which is required under the contract which cannot be carried out by the Contractor shall be carried out at the Contractors expense at an independent laboratory which is approved by the Supervision Consultant.

7. Acceptance:

The gradation will be acceptable when variation from the approved job mix for the average of four samples is within the limits of tolerances specified.

The asphalt content will be acceptable when variation from the approved job mix for the average of four samples is within the limits of tolerances specified.

The compaction density for all bituminous courses shall be equal to or greater than 98% of the average Marshall bulk specific gravity for each day's production unless otherwise directed by the Supervision Consultant. (90% of the results shall be greater than the lower specification tolerance limit of 96.3%).

Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

8. TESTING FREQUENCY

Work Item	**(A) Source of Materials**	
	Required Tests (A)	**Repetition Required for all Test in (A)**
Materials Used in Aspl mix (at batching plant)	1- Specific gravity and water absorption 2- Abrasion test 3- Chert content 4- Clay lumps and friable particles 5- Flaky and elongated particles 6- Soundness	Test for each source and/or When materials quality changes and/or As requested by the Supervision Consultant

Work Item	(A) Source of Materials	
	Required Tests (A)	**Repetition Required for all Test in (A)**
Materials Used in Aspl mix (from hot bins)#	1- Gradation 2- Specific gravity and water absorption 3- Plasticity index 4- Sand equivalent 5- Stripping with asphalt	Test for each source and/or When materials quality changes and/or As requested by the Supervision Consultant#
Asphalt Mix design E layer (At batching plant)#	1- Complete mix design 2- loss of stability	For each project and/or When materials quality changes and/or When results are not consistent with the mix design results and/or As requested by the Supervision Consultant#

Work Ite	(A) Source of Materials		(B) Control on Site (The Road)	
	Required Tests (A)	**Repetition Required for Test in (A)**	**Required Tests (B)**	**Repetition Required for all Tests in (B)**
	At BatchingPlant		Behind Spreader	
Asphalt fo each layer	1- Stability 2- Flow 3- Extraction (binder content and gradation) 4- Air voids 5- Voids in mineral aggregates 6- Daily Marshall density 7- Loss of Stability	Test each 3 working days and/or Test for each batching pl and/or As requested by the Supervision Consultant	1- Stability 2- Flow 3- Extraction (binder content and gradatio 4- Air voids 5- Voids in mineral aggregates 6- Daily Marshall dens 7-	Test each working days and/or Test for each batching plant and/or As requested by the Supervision Consultant
			1- Road density and thickness (after final compaction	Test every 800 m^2
			1- Loss of Stability	Once every 3 working days and/or As requested by the Supervision Consultant

L. INSTALLATION TOLERANCES

1. The fully compacted and completed bituminous course shall conform to the lines, grades and cross sections as shown on the Drawings.
2. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

   Base Course: Plus or minus 10 mm.

Wearing Course: Plus 6 mm, no minus.

3. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 3-m straightedge applied transversely or longitudinally to paved areas:

   Base Course: 6 mm.

   Surface Course: 3 mm.

   Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 6 mm.

4. The elevations of the finished course shall be checked by the Contractor in the presence of the Supervision Consultant at maximum intervals of 12.5 m, unless otherwise specified, and at intermediate points as directed.

5. The tolerances on elevations of the final bituminous wearing course surface shall not exceed 6 mm above or 10 mm below the elevation shown.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to AASHTO T 168.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an approved landfill.

B. Do not allow milled materials to accumulate on-site.

SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions of Contract and General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Agglomerated Cement tiles refer to landscape schedule for location

2. Cast in place concrete paving

B. For technical requirements of all external visible elements Contractor shall comply with the Specifications in this section. However, for aesthetic requirements Contractor shall comply with the Landscape Drawings and the Landscape Architect Specifications.

C. Related Sections include the following:

1. Division 32 Section 321216 "Asphalt Paving" for asphalt base under unit pavers.

1.3 DEFINITION

A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by the Supervision Consultant.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. including but not limited to the following:

1. Agglomerated Tiles.

2. Mortar and grout materials.

3. Edge restraints.

4. Precast concrete curbs.

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

C. Submit a complete method statement and materials submittal with detailed specification compliance sheet, for the Supervision Consultant’s approval.

D. Samples: For each type of finish indicated on exposed surfaces of units, in sets of 3, illustrating full range of finish, color and texture variations expected. The Supervision Consultant’s approval of the samples will not be considered final and the Supervision Consultant may reject any unit delivered to the Site, which do not, in his opinion, meet the required standards.

E. Samples for Initial Selection: For the following:

1. Each type of unit paving indicated.

2. Joint materials involving color selection.

3. Exposed edge restraints involving color selection.

F. Samples for Verification:

1. Full-size units of each type of unit paving indicated.

2. Joint materials.

3. Exposed edge restraints.

G. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests by a qualified independent testing agency.

H. Shop Drawings: Detail fabrication and installation of units. Indicate locations, plans, elevations, dimensions, shapes and cross sections of each unit. Indicate joints, reveals, and extent and location of each surface finish.

I. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified..

J. Source quality-control test reports.

K. Compatibility and Adhesion Test Reports: From latex-additive manufacturer indicating the following:

1. Mortar and grout containing latex additives have been tested with paving for compatibility and adhesion.

2. Interpretation of test results relative to mortar and grout performance and written recommendations for installation practices needed for adhesion.

1.5 QUALITY ASSURANCE

A. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Supervision Consultant and the Employer.

B. Fabricator Qualifications: Shall comply with the following requirements:

1. Has sufficient production capacity to produce required units without delaying the work.

2. Is experienced in manufacturing Agglomerated cement tiles similar to those indicated for this project and can demonstrate a record of successful in-service performance.

C. Installer Qualifications: An experienced installer who has completed unit paving installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Source Limitations: Obtain each type of unit paving, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

E. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated and approved by the Supervision Consultant.

F. Preconstruction Compatibility and Adhesion Testing: Submit to latex-additive manufacturer, for testing indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials are required to obtain optimum adhesion with, and will be nonstaining to, installed paving and other materials constituting paving installation.

2. Submit a sufficient number of paving material and other materials involved in installation to allow comprehensive testing.

3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

4. For materials failing tests, obtain mortar and grout manufacturer's written instructions for corrective measures, including the use of alternative materials to obtain optimum bond and prevent staining

G. Mockups: After sample approval and before fabricating units, product items requested by the Supervision Consultant for review by the Supervision Consultant. Incorporate full-scale details of architectural features, finishes, textures, and transitions in samples.

1. Locate mockup(s) where indicated or, if not indicated, as directed by the Supervision Consultant.

2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.

3. After acceptance of repair technique, maintain one sample panel at manufacturer’s plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.

4. Demolish and remove sample panels when directed.

5. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

6. Approval of mockups does not constitute approval of deviations from the Contract Documents unless such deviations are specifically approved by the Supervision Consultant in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to Project Site in such quantities and at such times to ensure continuity of installation.

B. Support units during shipment on nonstaining shock-absorbing material.

C. Place stored units so identification marks are clearly visible, and units can be inspected.

D. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

E. Store units at project site to prevent cracking, staining, or other physical damage to protective finish coatings.

F. Store tiles on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

G. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

H. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

I. Store liquids in tightly closed containers protected from freezing.

1.7 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paving work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Protect unit paving work against freezing when ambient temperature is 4 deg C and falling. Heat materials to provide mortar and grout temperatures between 4 and 49 deg C

2. Hot-Weather Requirements: Protect unit paving work when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 38 deg C and higher.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type 1 or AASHTO M 240.

B. Coarse Aggregate for Facing Mixes: ASTM C 33 or AASHTO M 180, hard, durable, carefully selected and graded; and shall meet the following requirements:

1.	Sodium sulfate soundness, percent loss	12 max
2.	Content of friable particles	max 1 % by weight
3.	Soft fragments	max 5 % by weight
4.	Flakiness index	15 %

C. Fine Aggregate for Facing Mixes: ASTM C 33 or AASHTO M 6; manufactured sand of same material as coarse aggregate, unless otherwise acceptable to The Supervision Consultant.

1. Fine aggregate shall meet the following requirements:

1.	Fineness modulus, AASHTO M 6	2.3 to 3.1
2.	Sodium sulfate soundness, percent loss	10 max
3.	Content of friable particles	max 1 % by weight
4.	Sand equivalent	min 75

D. Water: Drinkable, free from foreign materials in amounts harmful to concrete and embedded steel.

2.2 MIX DESIGN

A. Prepare design mixes for each type of concrete required.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel.

2.3 Agglomerated Tiles

A.

Provide and install factory agglomerated tilescomplying with the following requirements complementary to the general specifications.

Dimensions	:	As shown on the drawings.
Color	:	To the selection of the Engineer.
Finish	:	Smooth or as directed by the Engineer.
Density	:	Average of 2610kg/m^3 (ASTM C-97)
Compressive strength	:	100MPa (ASTM C-170)
Lateral strength	:	Transverse strength of 7.2 MPa.

Total absorption	:	6% by weight (ASTM C97)
Modulus of rupture	:	6.3 MPa (ASTM C99)
Abrasion resistance	:	Average of 0.57mm/after 1000 revolution
Type of installation	:	Laid on cement-sand mortar (1:4) mix
Properties	:	Mix of:

1- Cement: Portland cement complying with ASTM150Mpel.
2- Water: Free of any deleterious substances.
3- Aggregates: Natural aggregates, crushed marble/ stone chips, shall be natural and sound without excessive flats or flakes.
4- Additives: Synthetic pigments resistant to alkalis and none fading.

The mixture shall be submitted to the vacuum-vibrator factor to produce high-density blocks.
The test for compressive strength and for absorption of agglomerated cement shall comply with ASTM as mentioned by the Engineer
Size and thickness of tiles shall be as shown on drawings and/or as indicted by the Engineer.
Thickness 30 mm unless otherwise noted

2.4 CAST IN PLACE CONCRETE PAVING.

A. Concrete paving fine to medium brush stroke slightly textured surface with uneven linear transversal grooving colored

B. Cementitious Material: Portland Cement: ASTM C 150.

C. Normal-Weight Aggregates: ASTM C 33 uniformly graded. Provide aggregates from a single source.

1. Maximum Aggregate Size: 15 mm nominal.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: Potable and complying with ASTM C 94/C 94M.

E. Air-Entraining Admixture: ASTM C 260.

Thickness: 100 mm unless otherwise noted.

F. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures, mainly:

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.

4. Finish: as indicated on drawings

2.5 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.6 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185 & ASTM A 615/A 615M, Grade 60, mesh steel bars 8 mm diameter, spaced at 25 cm x 25 cm, unless otherwise specified.

1. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place.

2.7 ACCESSORIES

A. Job-Built Concrete Edge Restraints: Comply with requirements in Division 03 Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 20 MPa.

B. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.

C. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

D. Admixtures: Use air-entraining admixture in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete, may be used at Fabricator's option.

2.8 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with requirements in Division 31, Section 312100 for subbase material.

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with requirements in Division 31, Section 312200 for base course.

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.

D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing 1.18-mm sieve and no more than 10 percent passing 0.075-mm sieve.

1. Provide sand of color needed to produce required joint color.

F. Geotextile, where required: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288.

2.9 MORTAR SETTING-BED MATERIALS

A. Portland Cement: ASTM C 150, Type I or II.

B. Hydrated Lime: ASTM C 207, Type S.

C. Sand: ASTM C 144.

D. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.

E. Water: Potable.

F. Mortar: Sand /cement with plasticizer mortar (3:1) shall be composed of one part of cement to three parts of sand by volume with a mixture of an approved plasticizing agent, if required, added in accordance with the manufacturer's instructions. Mortar shall be mixed by approved mechanical mixers.

2.10 GROUT MATERIALS

A. Latex-Portland Cement Grout: ANSI A118.6, composition as follows:

1. Packaged, dry grout mix consisting of portland cement, graded aggregate, and ethylene vinyl acetate in the form of a reemulsifiable powder to which only water is added at Project site.

B. Water: Potable.

C. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144, or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

D. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for dry pack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time..

2.11 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

2.12 FABRICATION

A. General: Fabricate concrete units complying with manufacturing and testing procedures, quality control recommendations, and following dimensional tolerances unless otherwise indicated.

B. Fabricate units straight, smooth, and true to size and shape, with exposed edges and corners precise and square unless otherwise indicated.

C. Units which are cracked, broken, spalled, stained, or otherwise defective will not be acceptable.

D. Precast units shall be cast upside down in approved steel molds under conditions of controlled temperature and humidity. The units shall be steam cured, or cured by another method approved by the Supervision Consultant, until the concrete attains the full specified 28-day strength.

2.13 SOURCE QUALITY CONTROL

A. Engage an independent testing agency to evaluate precast concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Provide the testing agency with samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

2. Where paving are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

A. Clean unit surfaces which have become dirty or stained prior to setting to remove soil, stains and foreign materials. Clean units by thoroughly scrubbing with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh filler or abrasives

B. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

C. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

D. Proof-roll prepared subgrade according to requirements in Division 31 Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit paving with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix paving from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit paving tiles with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For agglomerated tiles pavement, a block splitter may be used.

D. Joint Pattern: As indicated on drawings and details.

E. Paving over Waterproofing: Exercise care in placing paving and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

F. Tolerances: do not exceed 0.8-mm unit-to-unit offset from flush or 3 mm in 3 m from level, or indicated slope, for finished surface of paving.

G. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide foam filler as backing for sealant-filled joints, unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavement. Sealant materials and installation are specified in Division 07 Section 079200 "Joint Sealants."

H. Provide edge restraints as indicated. Install edge restraints before placing unit pavement.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit pavement installation.

2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.

3. Install job-built concrete edge restraints to comply with requirements in Division 03 Section 033000 "Cast-in-Place Concrete."

4. Where pavement tiles set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavements set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavements. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

5. Where pavement tiles embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent AASHTO T 180 maximum density or ASTM D 1557 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Supervision Consultant, and replace with compacted backfill or fill as directed.

C. If indicated on Drawings, place separation geotextile over prepared subgrade, overlapping ends and edges at least 300 mm.

D. Place aggregate subbase and base, compact by tamping with plate vibrator, and screed to depth indicated.

E. If indicated on Drawings, place drainage geotextile over compacted base course, overlapping ends and edges at least 300 mm.

F. Place leveling course and screed to a thickness of 25 to 38 mm, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

G. Set pavers with a minimum joint width of 1.5 mm and a maximum of 3 mm, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 10 mm with pieces cut to fit from full-size unit pavers.

H. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

I. Do not allow traffic on installed pavers until sand has been vibrated into joints.

J. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavement tiles that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Repair unit pavers if permitted by the Supervision Consultant to match color, texture, and uniformity of surrounding units. The Supervision Consultant reserves the right to reject repaired units that do not comply with requirements.

C. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

D. Cleaning: Clean exposed surfaces of units after erection and completion of joint treatment to remove excess grout from exposed paver surfaces, weld marks, other markings, dirt, and stains; wash and scrub clean.

E. Perform cleaning procedures, if necessary, according to fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.

F. Do not use cleaning materials or processes that could change the appearance of exposed unit pavers finishes or damage adjacent materials.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the special inspections and prepare reports.

B. Remove and replace work that does not comply with specified requirements.
C. Additional testing and inspecting, at the Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

1.2 SUMMARY

A. Section Includes:

1. Trees.
2. Climbers.
3. Shrubs.
4. Hedges.
5. Ground cover.
6. Plants.
7. Tree stabilization.
8. Edgings.
9. Artificial plant.

B. Type of works required include the following:

1. Furnishing plants
2. Preparation of planting pits and planting area soil preparation.
3. Planting including mulching, trimming and staking.
4. Maintenance until final handing over
5. Related works specified under other specification sections (irrigation, …)

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

D. Bare-Root Stock: Exterior plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of exterior plant required.

E. Clump: Where three or more young trees were planted in a group and have grown together as a single tree having three or more main stems or trunks.

F. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.

G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.

H. Finish Grade: Elevation of finished surface of planting soil.

I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

J. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.

K. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

L. Sub-grade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

M. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each of the following:

1. Mineral mulch for each color and texture of stone required, in labeled plastic bags.
2. Edging materials and accessories, of manufacturer's standard size, to verify color selected.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Material Test Reports: For existing surface soil and imported topsoil when requested by the Engineer.

F. Planting Schedule: Indicating anticipated planting dates for exterior plants.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

H. Warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for plant growth. Recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 150 mm above the ground for trees up to 100-mm caliper size, and 300 mm above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

1. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

B. Do not prune trees and shrubs before delivery except as approved by Engineer. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery and handling.

C. Handle planting stock by root ball.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.

2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.

3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT CONDITIONS

A. Planting Restrictions: Plant during normal seasons for such works in location of project. Plant flowering trees during the Spring planting season, unless otherwise instructed by the Engineer.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.

C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Warranty all plant materials for a period of not less than 2 years after date of final handing over against defects including death and unsatisfactory growth except for abuse or damage by others or incidents beyond Contractor’s control.

1. Include the following remedial actions as a minimum:
   a. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
   b. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each exterior plant will be required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for replaced plant materials; warranty period equal to original warranty period.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs, Ground Cover and Plants: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below.

1. Maintenance Period: 24 months from date of final handing over.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully

branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Provide trees and shrubs of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to the Engineer, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

E. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

F. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1.

C. Large Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1.

D. Palm Trees: Natural form according to species and type, with relationship of caliper and height according to ANSI Z60.1.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

2.4 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1 and the following requirements:

2.5 CLIMBERS

A. Climbers: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1 and the following requirements:

2.6 PLANTING SOIL.

A. ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 25 mm or larger in any dimension and other extraneous materials harmful to plant growth.

1. Planting Source: Reuse surface soil stockpiled on-site (if any). Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
2. Planting Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites.

B. The Contractor shall provide a full chemical and physical soil analysis which has to include the pH value, electrical conductivity, CaCo3, texture as well as contents of Nitrogen, Phosphors, Potassium and Magnesium. The Contractor shall provide a soil analysis to prove that the soil meets the following requirements.

1. Electrical conductivity not exceeding 1500 micro mho/cm. If it is higher, leaching of the soil in a well drained area will be necessary, using a suggested water quantity of 300 l/m2 to a soil depth of 30 cm.
2. The sodium absorption ratio (SAR) to be no greater than 0.8.
3. The pH values to be between 5.5 and 7.
4. The boron concentration in saturation extract not to exceed 0.5 ppm.
5. The clay, silt and sand content should be
   a. Clay (less than 0.002 mm) : max. 30%
   b. Silt (0.002 - 0.005 mm) : max. 70%
   c. Sand (0.05 - 2 mm) : min. 50%
6. A minimum of 90 per cent by weight to pass a 2 mm round whole sieve.
7. The permeability rate not to be less than 1.25 cm per hour when tested in accordance with ASTM D 2434 or approved methods.
8. The maximum level of
   a. Available Phosphorus P2O5 : 10 mg/100g soil
   b. Available Magnesium Mg : 10 mg/100g soil
   c. Available Potassium K2O : 40 mg/100g soil

C. Analysis shall be done by a registered institution in the form of a written report. The analyses shall be made for every 500 m3 of soil delivered to the site and shall state that the source complies with specifications.

2.7 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid. Or as directed by the Landscape specialist

2.8 MULCHES

A. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:

1. Type: Rounded riverbed gravel or smooth-faced.
2. Size Range: 50 mm maximum, 19 mm minimum
3. Color: As per Engineer requirements

2.9 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 100-mm wide minimum, with stretch factor of 33 percent.

C. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

D. Planter Filter Fabric: Woven or nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

2.10 PLANTING SOIL MIX

A. Soil Mix for planting and planters: Use planting soil as directed by landscape specialist and to the approval of the Engineer.

2.11 PLANTS TYPES AND SPECIFICATION

A. Trees

1. Tree T/Bp Brachychiton populneus

   Net trunk h=2.2m

   Circumference=12-14cm

   H= 3.5-4.5m, spread as shown on drawings

2. T/Fa Ficus australis

   Net trunk h=2.2m

   Circumference=14-16cm

   Total height= 3.5-4.5m, spread as shown on drawings

B. Climbers

1. S/Rj Rhynocospermum jasminoides

   Pot size= 20cm

   Plant height= 2-3m

   Distribution: 3 per Lm

C. Shrubs

1. S/Pt Pittosporum Tobira

   Pot size= 24cm

   Plant height= 0.5m

   Distribution: 3 under each tree

2. S/Lj Ligustrum Japonicum

   Pot size= 24cm

   Plant height= 0.6m

   Distribution: 3 under each tree

3. S/Sa Schefflera Arboricola

   Pot size= 24cm

   Plant height= 0.8-1m

   Distribution: 3m apart

D. Ground Cover

1. Gc/Ln Lippia Nodiflora at sidewalks

   Pot size= 8cm

   Plant height= 0.1-0.2m

   Distribution: 16 per m^2

2. G/L Bouteloua at piazza & grandstand

   Pot size= Roll

   Distribution: as shown.

E. Artificial plant.

1. Artificial plant as shown on drawing and to be compliance with manufacturer requirements and approved by Engineer

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Engineer's acceptance of layout before planting. Make minor adjustments as required.

D. Lay out exterior plants at locations directed by the Engineer. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

E. Trunk Wrapping: Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.

F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING BED ESTABLISHMENT

A. Loosen sub-grade of planting beds to a minimum depth of 150 mm. Remove stones larger than 50 mm in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property. naughty

1. Apply fertilizer directly to sub grade before loosening.
    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. Mix lime with dry soil before mixing fertilizer.
2. Spread planting soil mix to a depth of 300 mm but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or sub grade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, restore planting beds if eroded or otherwise disturbed after finish grading.

3.4 TREE AND SHRUB PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

B. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball 25 to50 mm above adjacent finish grades. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

C. Set container-grown stock as specified for balled and burlapped stock, except remove container before setting. Carefully remove cover and sides of wooden boxes after partial backfilling without damaging root ball or plant.

1. Carefully remove root ball from container without damaging root ball or plant.

2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

D. Mulch pits, trenches and planted area: Provide at least 75mm layer of mulch on top of the root-ball.

E. Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees of 50-mm caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.

F. Stake trees of 50 mm or greater caliper. Stake trees of less than 50 mm caliper only as required to prevent wind "tip-out". Trees that require staking shall be staked in accordance with the tree planting and staking details show on the drawings.

3.5 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

3.6 TREE STABILIZATION

A. Trunk Stabilization: Unless otherwise indicated, provide trunk stabilization as follows:

1. Use 2 stakes for trees up to 3.6 m high and 65 mm or less in caliper; 3 stakes for trees less than 4.2 m high and up to 100 mm in caliper. Space stakes equally around trees.

2. Support trees with two strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Guying and Staking: Guy and stake trees exceeding 4.2 m in height and more than 75 mm in caliper unless otherwise indicated. Securely attach no fewer than 3 guys to stakes 760 mm long, driven to grade.

C. Root-Ball Stabilization: Unless otherwise indicated, provide at- or below-grade stabilization system to secure each new planting by the root ball.

D. Palm Bracing: Unless otherwise indicated, provide bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established.

1. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.

3.7 PLANTING IN PLANTERS

A. Place a layer of drainage gravel at least 100 mm thick in bottom of planters, cover with filter fabric, and fill with planter soil mix. Place soil in lightly compacted layers to an elevation of 38 mm) below top of planter, allowing natural settlement.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants as indicated in drawings and schedules.

B. Dig holes large enough to allow spreading of roots and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANT MAINTENANCE

A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing stakes and root-ball stabilization, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.

B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

3.10 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.11 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

SECTION 142100 - ELEVATOR

PART 4 - GENERAL

2.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions.

2.1 SUMMARY

A. This section specifies the engineering, furnishing and installation of complete and ready for operation electric traction elevator systems described herein according to schedule of elevators attached and as indicated on the contract drawings.

1. Section includes:
2. Passenger Lifts
3. Patient lifts
4. Related Sections include the following:
5. Division 03 Section “Cast-in-Place Concrete” for setting sleeves, inserts, and anchoring devices in concrete.
6. Division 04 Section "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
7. Division 05 Section "Structural Steel Framing".

2.1 ALLOWANCES:

A. Provide finished passenger elevator car under the Elevator Car Allowance specified in Division 01 Section "Allowances." Allowance includes furnishing and installing the following:

1. Car wall finishes including trim.
2. Car floor finishes.
3. Car ceiling finishes.
4. Car and hoist way door finishes.
5. Car door sills.

6. Car light fixtures.
7. Handrails.
8. Cutouts and other provisions for installing elevator signal equipment in cars.
9. Galvanized steel ladder should be provided for elevator pit.
10. Complete hoist way lighting installations including conduits, boxes, wiring, fixtures, switches, etc… shall be applied.
11. Secondary steel structure including separation beams, structural supports, etc…

2.1 ACTION SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoist way entrances, and operation, control, and signal systems. Include product data, but not limited to the following:

1. Car enclosures and Hoist way entrances
2. Operation, Control and Signal Systems

d.

B. Shop Drawings:

1. Scaled Layout Drawing to an appropriate, readable scale dimension indicating all relevant shaft, machine room, and elevator information including but not limited to:

a. Reactions, rail loads, fixings points, steel work, support/elevator points
b. Entrances, equipment arrangement, signal cut outs
c. Power requirements, acceleration / full load current, regenerative loads for applicable motors and power conversion units.
d. Car design drawing with Car Operating Panel layout and lighting
e. Levelling Accuracy- +/- 5mm under all load conditions.
f. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

e.

C. Samples for Initial Selection and Verification

1. Hall push buttons, hall position indicator (as applicable), fireman switches.
2. Car push buttons, alarm button, door open button and key switches

3. Car interior finishes 150mm x 200mm and fittings handrails, mirror, flooring and all items indicated in drawings.
4. Car Design drawing with car operating panel layout and lighting (as per the interior finishes
5. Lighting fixture.
6. For exposed finishes of cars, hoist way doors and frames, and signal equipment; 75-mm square samples of sheet materials; and 100-mm lengths of running trim members.

D. Manufacturer Certificates:

1. Manufacturer shall be ISO 9001:2008 or 2015 certified or one certified as employing an equivalent or higher system of quality management; having a minimum of 20 years documented experience in the manufacture of product/s specified in this Part and capable of providing field service representation, as required by Engineer, during installation.
2. Signed by elevator manufacturer certifying that hoist way, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided

E. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

2.1 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Employer, in the form of a standard minimum of 1 Year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
D. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Employer with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

2.1 QUALITY ASSURANCE

A. Manufacturer’s Qualification: Manufacturer shall be ISO 9001:2008 or 2015 certified or one certified as employing an equivalent or higher system of quality management; having a minimum of 20 years documented experience in the manufacture of product/s specified in this Part and capable of providing field service representation, as required by Engineer, during installation.
B. Installer's Qualification: Highly-experienced Installer; having a successful in-service record for the installation of Conveying Equipment / Lift product/s, of type and scope similar as those required for the Project.
C. Code Compliance & General Specifications: Regulations and Regulatory Bodies (but not limited to):
    1. EN 81-20 and EN 81-50 European standards for Elevators.
    2. EN 81-70 European standard Accessibility to Elevators.
    3. EN 81-72 European standard for Fire Fighting Elevators.
    4. Civil Defense requirements for Elevators and Escalators as applicable.
    5. Fire Mans Use as per EN 81-1 / Civil Defense requirements
    6. Note: All Passenger elevators to be provided with Main Floor Fireman’s access control with car Phase 1 & Phase 2 operation and alternative floor fire recall.
    7. Earthquake Emergency return - (EN 81-77)
    8. Local Codes, Ordinances and Laws.
    9. EN 13501-1 European standard for Fire classification requirements.

D. Requirements:

1. Elevator contractor shall manufacture, deliver, install, test / commissioning and hand over the complete elevators as specified and in accordance with BS EN 81 / JIS codes Elevator Safety Code. This work shall be done in accordance with local codes which may govern the requirements.
2. Where applicable type tested certificates, in English, are to be supplied.
3. The specific requirements of the elevators and particular specifications are given in the Schedules following.
4. The Elevator contractor shall commence the electrical installation from the circuit breakers provided in the machine room for this purpose by related trade. All the works shall be coordinated with the other contractors prior to installation, so that there will be no areas of incompatibility. The Elevator contractor shall include clear and specific power requirements in their tender bid.
5. The elevator system shall be equipped with geared / gearless traction machinery as applicable and associated traction equipment, elevator cars, latest solid state control systems and all other equipment and accessories required to provide a complete, modern, durable and efficient vertical transport system.
6. All the electrical equipment shall be compatible with the available electrical system of the building, as specified under electrical section.
7. All the components shall be selected to provide satisfactory operation under prevailing environment condition at site.
8. As Installed Drawings and Services Manuals: On completion of the elevators installation and at least one week prior to the date of inspection, the Elevator Contractor shall hand over to the Lead Consultant as- installed elevator installation drawings.
9. Two sets of printed and bound instruction manuals for general running and maintenance are to be provided.

E. Deviations / Clarifications:

1. Any and all deviations and/or clarifications to the following specifications, schedules and appendix must be clearly stated in the tender offer with details of the deviation/clarification and reason.

2. Details of alternatives are to be provided at the time of tendering making reference to the page number, clause and sub-clause for ease of cross reference.
3. Failure to comply with this requirement will imply compliance with the specifications, schedules and appendix and any works found to be not in compliance will have to be replaced to meet requirements at the cost of the Elevator Contractor.
4. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

2.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer’s protective packaging in the storage area provided by the Main Contractor at site.
B. Store materials, components, and equipment off the ground, under cover, and in a dry location provided by the Main Contractor at site. Handle according to Elevator Contractor written recommendations to prevent damage, deterioration, or soiling.

2.1 COORDINATION

A. Coordinate sequence of elevator installation with other work to avoid delaying the work.
B. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
C. The Main Contractor provision related to builders works, shall include but not limited to the following:

1. Basis of Design / Non-Restricted by Lift Manufacturer
2. Electric Power of necessary characteristics during installation of elevators to provide shaft illumination, operation of required tools, hoisting machines and power for starting, testing, adjusting and running the elevators, not limited to:

a. as shown on our layout drawing.
b. Supply and fix in the shaft one 13 AMP single -phase socket outlet.
c. Make available as and when required adequate 3-phase power supply for any purpose; adjusting, testing and commissioning, and handing over of elevators.

1. Cut outs in concrete (rough openings) to accommodate elevator entrances, (including landings for emergency access door/s) car installation and signalization fixtures. Reinforced concrete slabs constructed at the top of shaft for all elevators.
2. Concrete and steel works required for fire rated and plumb shafts, machine rooms, secondary levels (if required), and pits. Elevator shafts will be constructed without projections. All builders work before, throughout, and after installation & handing over of lifts.
3. All required separator Steel Beams; & Accessories, including Lifting hooks and/or Lifting beams with the required capacity. Supports to carry all structural reaction, impact and up elevator loads imposed by the elevator equipment shall be Design, Supply & Installed by Main Contractor in coordination with Lift Contractor.
4. Temporary protection at the landings and double protection in the elevator shaft to allow the elevator contractor to work in the shafts whilst the construction continues above.
5. Masonry, grouting, and filling, of elevator shaft entrances and landing sills, steel work, boxes, frames, decorative entrances etc.
6. Waterproofing to keep pits dry.
7. Elevator machine room access door, secondary level access door (if required). In addition, Machine room railings, cat ladders, floor cut-outs and painting, are to be provided by main-contractor.
8. Air Relief Ventilations; Manufacturer will provide full details, vents, size & location, where required.
9. Permanent air conditioning necessary to keep Machine Room & Machine Room-less motors temperature below 40˚C, based on heat release data to be provided by Manufacturer
10. Proper electric feeder wires to controllers as determined by Manufacturer, including necessary mainline switches, circuit breakers or fuses. Supplementary disconnect switches at remote locations. Necessary outlets or feeder wires to controllers as necessary for signal circuit, car lights, car fans, in pit for pit power socket, and in hoist way for shaft lighting.
11. Containment outside the elevator shafts, elevator machine rooms.
12. Sufficient emergency power to run elevator at full load and full speed at any one time in testing.
13. Elevator emergency power transfer switch will be provided with an in phase monitoring device to ensure available power sources (emergency and normal) are in phase prior to switch transferring. Generators and cabling to controllers, as required by Manufacturer, for Emergency Power Operation, are to be provided by main-contractor.
14. Manufacturer will coordinate the following with other contractors, if any:

a. Which elevator controllers the signal wiring for the fire alarm and emergency power are to be run to.

1. Provide a datum line in elevation at each landing to enable the lift door sills to be installed in relation to the finished floor level.
2. Provide adequate secured storage for equipment and Lift contractor's tools on job sit at all times.
3. Provide unhindered access for unloading and distribution of lift equipment on site.
4. Cabin Protection for temporary usage, as required for temporary usage. (To be at additional price)
5. Fireman Service Connectivity to main fire control panel including 24/7, by others.
6. Filling of wide jambs with suitable filler to ensure the fire rating of the shaft, by main-contractor.
7. Provide auxiliary cables, conduits as required, up to lift contractor's equipment for purpose of connecting fireman's control, card reader, intercom and other functions not related to the lift operation.
8. All installation working platforms, with design, quantity, and location as required by manufacturer engineers
9. Permanent shaft lighting to meet code requirements
10. All guarding of equipment.
11. Preparation of Fire Fighting Elevator shaft in terms of water ingress prevention, drainage of lift pit or pumping of same according to EN 81-72:2015.
12. Temporary Facilities: The main contractor shall provide the following temporary facilities for the Lifts Contractor
13. Water & Electricity for the Works
14. Site Security and Protection
15. Site cleaning / keeping free from rubbish
16. Site Storage
17. Fully equipped site offices
18. Utilities connection and consumption charges for site offices (Water, Electricity, & Telecommunication)
19. Site Office Housekeeping & Maintenance
20. Sanitary and welfare facilities for workers

21. General Crane & Scaffolding

D. Other Facilities and General Items:

1. All other facilities/general items required for the Lift Works such as, Transport of workers/equipment, performance guarantee, insurance etc. shall be provided by the Lift Contractor.

2. Any other special requirements with regards to temporary facilities for carrying out the Lift Works under this Contract shall be arranged by the Lift Contractor.

2.1 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

2. Warranty Period: 1 year from date of Substantial Completion.

PART 5 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Product: Reference to Schedule of Finishes, the named product establishes the salient features against which comparable products of the several manufactures listed may be evaluated. Qualities may include type, function, dimension, in service performance, physical properties, appearance and other characteristics. Engineer will consider comparable products, provided they meet the significant qualities of the product specified.

B. Restricted Products: Subject to compliance with the requirements, provide products as listed in Appendix Schedule of Finishes. Comparable products or substitution for Contractor’s convenience are not allowed on this category.

C. Non-Restricted Products: Subject to compliance with requirements, available manufacturer offering products that may be incorporated into the work include, but are not limited to items stipulated in Schedule of Finishes. Contractor is allowed to submit product that complies with the requirements for Employer/Engineers evaluation and approval.

D. Named Bench Mark Products:

1. The naming of particular proprietary („benchmark") products indicates products of acceptable quality and design intent which may be approved, but does not mean exclusive preference for such products. Equivalent products may be used.
2. Before commencing, verify the correct selection of appropriate products for the substrates and conditions in accordance with the Product Information.
3. Submit details of proposed products for Employer or Engineer approval before commencing procurement.
4. The naming of proprietary products does not reduce or modify the Contractor's responsibility to comply with the Contract Documents and warrant the work.

E. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Kone.
2. Mitsubishi
3. OTIS
4. Or approved equal.

2.2 FIRE LIFE SAFETY GENERAL

A. Use materials complying with minimum requirements as stipulated in LIFE SAFETY CODE OF PRACTICE 2017 referred as "Civil Defense Fire Code" and applicable NFPA Codes and Standards. Whenever the conflicts arise between requirements of different departments the minimum requirements of Life Safety Code of Practice shall surpass all other requirements unless other requirements are higher than the "Civil Defense Fire Code"

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with EN 81 or ASME A17.1/CSA B44.
B. Accessibility Requirements: Comply with EN 81-70 or Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
C. Firefighting Requirements: Comply with EN 81-72.
D. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7and shall comply with elevator safety requirements for seismic risk Zone 2A or greater in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event
2. Provide earthquake equipment required by EN 81 or ASME A17.1/CSA B44.
3. Provide seismic switch required by EN 81 or ASCE/SEI 7.
4. Design earthquake spectral response acceleration short period (Sds) for Project according to Manufacturer standard
5. Project Seismic Design Category: Reference to Dubai Municipality
6. Elevator Component Importance Factor: 1.5

2.4 ELEVATORS

A. General:

1. Provide manufactures standard elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard pre-engineered elevator systems and is as required for the complete system.
2. Harmonics produced shall be within permitted IEC at the point-of-common-coupling of the power supply feed. Special care shall be taken to incorporate into the design of the lift cars, aspects to ensure that during rapid ascent or descent, car air-pressure variations do not produce an unpleasant effect (Nausea) for the passengers Traction Machine.

2.5 PASSENGER & FIRE/SERVICE ELEVATORS

A. Basis of Design: Refer to the Annex 1 shown at the end of section.
B. Technical Properties: Refer to the Annex 1 at the end of the section.

2.6 SPECIAL FEATURES

A. Refer to Annex 1 at the end of the section

2.7 GENERAL SYSTEM AND COMPONENT

A. The traction machine as specified:

1. The traction machine should be securely fixed and isolated by isolation pads.
2. The elevator shall be equipped with variable voltage and variable frequency

3. Controlled geared/gearless motors as applicable, having step-less, smooth speed time characteristics.
4. The system shall combine the latest VVVF control utilizing vector control and IGBT transistors. The traction sheave shall be made of suitable material to provide good wearing proper-ties of both ropes and sheaves
5. DC operated electromagnetic double independent brakes shall be provided. The brake shoes being electrically held off the brake drum and mechanically applied by compression springs. A manual break release shall be provided to facilitate hand movement of the elevator
6. Preference shall be for permanent magnet synchronous motor in case of MRL to provide highest possible efficiency. The permanent magnet synchronous motor efficiency shall be 92 - 95% and have a zero slip factor
7. Motor shall have protection against overheating and burning by the use of thyristor. If the hoisting motor starts to overheat, the elevator car is driven to the nearest floor where the doors will be opened to let the passenger out of the car. After the motor cools down the elevator will resume normal operation. In the event of a motor over-heating, provide in the car operating panel a display which will illuminate advising persons to leave the car in this event.
8. The winding insulation levels of the motors shall be of insulation Class ‘F’ and the motors shall meet the requirements of BS EN 81/ JIS standards.
9. Motor Drive: The variable voltage, variable frequency motor drive {V3F} unit will control the motor speed using a microprocessor. The V3F system will be provided with a converter which performs AC - to - DC conversion and an inverter which is designed to invert DC to three phase variable frequency AC. The inverter will give an output of sinusoidal current by application of pulse width modulation technology. The inverter will control voltage and frequency continuously and accurately in accordance with speed command signal, which is performed by a microprocessor in the elevator controller
10. The V3F drive unit will be capable of keeping the elevator service under the following condition;

a. Supply Line Voltage Fluctuation: 10% + 5 % from the rated voltage o Frequency Variation - + 2% from the rated frequency
b. The V3F drive unit will be provided with contactors for removing the power from the motor of the traction machine. The Contactors will open each time the car stops.
c. The brakes of the traction machine will be applied while the contacts dropout
d. A pulse rotary encoder will detect the actual speed of the car. The difference between the speed command signal and the actual speed measured by the pulse rotary encoder will control the motor speed while the car is accelerating, decelerating and landing

e. Protective devices will ensure to open the main circuit between the VVVF unit and the motor of the traction machine to stop the elevator when one of the following conditions occurs:

f. Phase reversal; phase failure

g. Failure of supply voltage

h. Over current

i. Overheating of thyristor and transistor Operation of any safety device

- Minimum/Maximum motor acceleration and jerk rates are to be as the following:
  - Speed: >2.00 m/s Acceleration: 1.0 m/s2 Jerk: 1.6 m/s3
  - Speed: >1.75 m/s Acceleration: 0.6 m/s2 Jerk: 0.8 m/s3
- Maximum Lateral Quaking gal accepted for ride comfort class (1 gal equals to 1.02mg)
  - Speed: <2.00 m/s Maximum: 11.8 Minimum: 21.8
  - Speed: <5.00 m/s Maximum: 13.6 Minimum 23.6
- Maximum vertical Vibration gal accepted for ride comfort class (1 gal equals to 1.02mg)
  - Speed: <2.00 m/s Maximum: 16.3 Minimum: 26.3
  - Speed: <5.00 m/s Maximum: 17.5 Minimum 23.6

2.8 TRACTION SYSTEMS

A. Elevator Machines: Variable-voltage, variable-frequency, ac-type hoisting machines or variable-voltage dc-type hoisting machines and solid-state power converters.
   - Provide regenerative or non-regenerative system as recommended by the Manufacturer.
   - Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
   - Provide means for absorbing regenerated power when elevator system is operating on standby power.
   - Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

B. Fluid for Hydraulic Buffers: If using hydraulic buffers, use only fire-resistant fluid.

C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

D. Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 055000 "Metal Fabrications" for materials and fabrication.

E. Car Frame and Platform: Bolted- or welded-steel units.

F. Guides: Roller guides or polymer-coated, non-lubricated sliding guides. Provide guides at top and bottom of car and counterweight frames.

2.9 OPERATION SYSTEMS

A. General: Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Group Automatic Operation with Demand-Based Dispatching: Provide reprogrammable group automatic system that assigns cars to hall calls based on a dispatching program designed to minimize passenger waiting time and or time to destination. System automatically adjusts to demand changes for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.

C. Destination-Based Group Automatic Operation: Provide reprogrammable group automatic system that assigns elevators leaving the main lobby in the up direction to a selected group of floors and directs passengers to an elevator serving their destination floor. System dispatches cars in a regulated sequence for optimum system efficiency; dispatch is based on origin and destination of calls. System automatically adjusts to changes in demand for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off- hours as variations of normal two-way traffic.

D. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:

E. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at designated area recommended by the Manufacturer Literature. Manual operation causes automatic operation to cease.

F. Single-Car Standby-Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.

G. Single-Car Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

H. Group Standby Power Operation: On activation of standby power, cars are returned to a designated floor and parked with doors open. One car is returned at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel. Manual operation causes automatic operation to cease.

I. Group Standby Power Operation: On activation of standby power, cars are returned, one at a time, to a designated floor and parked with doors open. If a car cannot be returned, it is removed from

the system. When all cars have been returned or removed from the system, one car can be put in service on standby power by a selector switch in control panel.

J. Group Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered one at a time to the next floor below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

K. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.

L. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.

M. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.

N. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed and distributed in predetermined zones throughout the building. One zone shall include the main floor and adjacent floors; remaining floors shall be divided into approximately equal zones.

O. Independent Service: Key switch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from key switch when car is in independent service. When in independent service, doors close only in response to door close button.

P. Priority Service: Service is initiated by a card reader or as recommended by Manufacturer at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks and a lighted sign directs passengers to exit elevator. Car is placed in operation by selecting a floor and pressing door close button or by operating key switch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.

Q. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

R. Card-Reader Operation: System uses card readers at car-control station and hall push-button stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car or Provide stripe-swipe card reader integral with each car- control station.

S. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed. Car calls for restricted landings do

not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.

T. Access codes are programmed at each car operating panel using a security key switch. Keypad operation can be activated and deactivated by security key switch at main landing.

U. Car-to-Lobby Feature: Feature, activated by key switch at main lobby, that causes all cars in a group to return immediately to lobby and open doors for inspection. On deactivation by key switch, calls registered before key switch activation are completed and normal operation is resumed.

2.10 DOOR OPERATOR AND REOPENING DEVICES

A. General:

- The door operator shall be a heavy duty variable speed controlled AC motor with V3F control suitable for the specified duty.
- The inverter shall include high speed switching device which in turn shall provide a smooth sine curve of output current to assure smooth, quiet and precise door control.
- The opening and closing speeds of the doors shall be adjustable.
- The landing and car doors shall operate in full synchronism.
- Advance door opening during car's approach to a landing shall be included to minimize the passenger transfer time
- Safety Features: Emergency unlocking key from landing side for evacuation.
- Pressure sensitive door reversal device is to be fitted to the car door operator.
- An infra-red light beam covers the full width of the door as it opens or closes to detect passengers or objects to reverse the doors if there is any obstruction when closing.
- Retractable safety edge is acceptable.
- Door nudging feature will operate when the doors are impeded from closing. After a predetermined time, the doors will close at slow speed and sound a warning buzzer. If the obstruction fails to move the doors will re-open and repeat the operation until the obstruction is removed.
- Electrical interlock to operate in conjunction with the car and landing doors, so that elevators cannot operate unless doors are fully closed.
- Door Load Detector: When an object is caught in opening/closing doors, the doors will reverse its direction when an excess load is detected. For example, when a pebble becomes lodged in the door track, rather than force itself open/close, the reverse cycle is to be repeated until the problem is eliminated.
- Automatic door open time adjustment: The system judges the situation whether each car stops responding to a car call or a hall call and controls the time of the doors stay open accordingly. The time spent waiting for the elevator is thereby shortened and operating efficiency is increased.
- Door Operation Feature: In the event of any door safety device malfunction, a temporary override function is to be automatically engaged to close the doors, thereby preventing a fault in elevator operation. Once the doors close completely, the override has to be cleared and normal operation resumes.

- Door Nudging Feature: In the event of the doors being continually obstructed or the door open button is continually activated for a given period a buzzer will repeat until the obstruction is removed.

2.11 CAR ENCLOSURES

A. General: Provide Car Enclosures Finishes according to Employer / Engineer approved sample.
   - Lift Interior Finishes: As indicated in Drawing and Schedule of Finishes
   - Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

B. Materials and Finishes: Manufacturer's standards, but not less than the following:
   - Subfloor: Exterior, underlayment grade plywood, not less than 15.9-mm nominal thickness.
   - Subfloor: Exterior, C-C Plugged grade plywood, not less than 22.2-mmnominal thickness.
   - Floor Finish: Elevator manufacturer's standard to be selected by Employer / Engineer from full range of industry colors.
   - Fabricate car with recesses and cutouts for signal equipment.
   - Fabricate car door frame integrally with front wall of car.
   - Sight Guards: Provide sight guards on car doors.
   - Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

2.12 HOISTWAY ENTRANCES

- Hoist way Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoist way entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoist way wall construction.
- Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.

A. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252orUL 10B.

B. Materials and Fabrication: Manufacturer's standards

2.13 SIGNAL EQUIPMENT

A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life lamps and acrylic or other permanent, non-yellowing translucent plastic diffusers or LEDs.

B. Car-Control Stations: Provide manufacturer's standard car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

- Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
- Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

- Mark buttons and switches for function. Use both tactile symbols and Braille.
- Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush- mounted cabinet, with identification, instructions for use, and battery backup power supply.

E. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet or telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Car Position Indicator: Provide illuminated, or digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

F. Hall Push-Button Stations:

- Provide according to Manufacturer standard for Employer / Engineers approval
- Equip units with buttons for calling elevator and for indicating desired direction of travel.
- Equip units with buttons for calling elevator and for indicating direction of travel or destination as required by system. Provide a signaling system to verify floor selection, where destination registration is required, and to direct passengers to appropriate car.
- Provide a means for passengers to indicate that they have disabilities so control system can allow extra room in assigned car.
- Provide for connecting units that require destination registration to building security access system so a card reader can be used to register calls.

G. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:

- Manufacturer's standard wall-mounted units, for mounting above entrance frames.

- Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
- Units mounted in both jambs of entrance frame for each elevator.

H. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
   - At manufacturer's option, audible signals may be placed on cars.

I. Hall Position Indicators: Provide illuminated, digital-display-type position indicators, located above each hoist way entrance at all floors. Provide units with flat faceplate for mounting and with body of unit recessed in wall.
   - Integrate hall lanterns with hall position indicators.

J. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed and for each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.

K. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch/switches, as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.

L. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.14 FINISH MATERIALS

A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoist way entrance doors and frames, and signal equipment as indicated in drawing and schedule of finishes and to be approved by the Engineer from Manufacturers range of finishes selection.

PART 6 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoist way, hoist way

openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions.
B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
E. Alignment: Coordinate installation of hoist way entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
F. Leveling Tolerance: 3 mm, up or down, regardless of load and travel direction.
G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with non-shrink, nonmetallic grout.
H. Locate hall signal equipment for elevators as follows unless otherwise indicated:
    - For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
    - Place hall lanterns either above or beside each hoist way entrance.
    - Mount hall lanterns at a minimum of 1829 mm above finished floor.

3.3 SITE QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
B. Operating Test: Load one elevator of each type, capacity, speed, and travel distance to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and

proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.

C. Advise Employer / Engineer and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for each elevator used for construction purposes:
   - Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
   - Provide strippable protective film on entrance and car doors and frames.
   - Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
   - Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
   - Do not load elevators beyond their rated weight capacity.
   - Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
   - Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Employer's maintenance personnel to operate, adjust, and maintain elevator(s).

B. Check operation of each elevator with Employer's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

C. Check operation of each elevator with Employers representative

A. MAINTENANCE

B. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 Months full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

- Perform maintenance during normal working hours.
- Perform emergency callback service during normal working hours with response time of One hour or less.
- Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of One hour or less.

A. Lifts Characteristics

A1. Passenger Lift

a. Technical

- Number of lifts : 2
- Type of service : Passengers (visitor)
- Nb of persons: 13 (1000 Kg)
- Speed (m/s) : 1
- Power drive : Variable voltage, Variable frequency
- Operation : Full collective
- Group : Duplex

- Machine: Gearless traction machine and compact motor installed on top of guide rails.
  - Power supply : 380V-3Ph-50Hz
  - Number of stops : 4
  - Doors type : Automatic, Central opening
  - Travel (m) : 16.22m
  - Door opening (m) : 1.1 m structural opening 0.9m clear opening

b. Finishes

- Ceiling : Flat decorative ceiling with spots
- Panels : Hairline brushed Stainless Steel
- Mirror : Rear side, half height
- Handrails : Rear side, circular bar shape, Ø 38mm, brushed Stainless Steel.
- Car Entrance : Brushed Stainless Steel
- Car Door : Brushed Stainless Steel
- Flooring : Vinyl tiles 30cm x 30cm

A2. Patient Lift

a. Technical

- Number of lift: 2
- Type of service: Patient
- Nb. of persons: 16 (1250 Kg)
- Speed: 0.6 m/s
- Power drive: Variable voltage, variable frequency

- Machine: Gearless traction machine and compact motor installed on top of guide rails.
  - Power supply: 380V-3Ph-50HZ
  - Number of stops: 4 stops
  - Door type: Automatic control opening
  - Travel: 16.22 m
  - Door opening: 1.4 m structural opening 1.2m clear opening
  - Group: Duplex

b. Finishes

- Ceiling : Flat decorative ceiling with spots
- Panels : Hairline brushed Stainless Steel
- Handrails : Rear side, circular bar shape, Ø 38mm, brushed Stainless Steel.
- Car Entrance : Brushed Stainless Steel
- Car Door : Brushed Stainless Steel
- Flooring : Vinyl tiles 30cm x 30cm

B. General Requirements

C.1 Machine

Shall be of the single wrap traction type and shall include a motor, electro-mechanical brake, gear, steel sheave shaft, etc..., all compactly mounted on a single plate. Motor shall be squirrel cage induction especially designed for variable voltage, variable frequency drive. Brake will be spring applied and electrically released, designed to provide smooth stops under variable loads.

C.2 Car construction

Comprises structural steel frame members suitably braced and fastened together. The roof is to be reinforced with a trap door (at least 500mm x 600mm) opening outward and capable of being opened from both sides. Opening of trap is to prevent operation of lift. Load weighing device to be built into floor. Micro switches are also to be installed to by-pass landing calls when car is loaded to about 85% capacity. Calls shall remain registered to be attended by next “free” car.

Guide devices are to be adjustable and fastened to the top and bottom of car frame. Each car is to have necessary lighting and exhaust fan. Fan and lighting are to switch on automatically when car is called on when landing doors are opened, remain on while the car is in operation and switch off after a time delay after car has stopped. Fluorescent lamps are to be of the rapid start type. An emergency power unit employing 12V sealed rechargeable battery and static circuits shall be provided to illuminate the car(s) and provide current to the alarm bell in the event of power failure, and this for a period of 6 hours.

(Car finishes: stainless steel).

Doors to be automatic central opening

C.3 Guide rails

Are to be planed steel tees, provided as guides for the car and counterweight, and shall be securely fastened to the building’s structure.

C.4 Counter weight

To be of a suitable guided structural steel frame with appropriate sub-weights to promote smooth and economical operation.

C.5 Suspension ropes

Are to be of high grade traction steel of suitable size. Ropes are to be securely attached to car and counterweight and are to have independent means of adjustment.

C.6 Safety gear

Is to be provided to stop the car whenever excessive descending speed is attained. Operation is got by a centrifugal speed governor located at the top of the hoistway. Stopping method to be smooth, and suitable means are to be provided to cut off the power as a first step and if the speed exceeds the first step then a braking system is applied to activate as a second step.

C.7 Buffers

Are to be installed under each car and counter weight. Buffers are to be mounted on steel channels in the pit.

C.8 Controller

Is to be of the totally enclosed cubicle type, constructed from sheet steel provided with ventilation louvres. Controller to include protection against the following:

- No voltage or sustained under voltage,
- Overcurrent,
- Phase reversal of power supply,
- Any phase missing
- Overload

Controller is to cut off power supply, apply brake and bring car to rest in the event of any of the above failures.

C.9 Emergency rescue device

Is to be provided to enable the elevator stop at the nearest floor in case of power failure.

C.10 Car control panel

Is to be located in an approved position and to contain at least the following:

- Up and down illuminated arrows
- Floor digital position
- Alarm push button
- Pushes for each floor served (illuminated)
- Emergency stop push button
- Key operated car switch
- Attendant key operated switch
- Card reader (to allow elevator serve N-5 level, refer to D. control system
- Door open and close push buttons,
- Fan key switch
- Overweight buzzer

- Intercom unit, powered by an emergency battery supply.

C.11 Top of car inspection buttons

Are to be installed on top of the car to give the inspector manual control of the car.

C.12 Directional indicators at landings

Are to be installed at each lift entrance to indicate arrival and direction of car arriving at landing.

Gong is to be provided to indicate car arrival. Push buttons at landings are to comprise illuminated up and down pushes. Terminal landings are to have one push. At level N-5 call push button is to be replaced by a card reader to allow car call by authorized personnel only.

C.13 Emergency key

Is to be handed to the client to open all landing doors

C.14 Hoistways and pits

Are to be illuminated using 100w covered lights (weatherproof, IP54 minimum) at regular intervals protected with an adequate circuit breaker installed in the machine room.

C.15 Wires and cables

Inside machine room, wires and cables are to be PVC insulated, 600/1000V grade, flame retardant. Conductors are to be copper. Metal frames of installations are to be earthed.

C. Control System (Full Collective)

No car is to be able to move unless car and corresponding landing door are fully closed and interlocked. It is not possible to open landing door except that at which car is stopped or using a special key. Operation of emergency stop device in any car is to bring this car to an immediate stop and to remain stopped until device is reset.

The group of lifts shall employ “a full collective group” control system. The number of cards is limited to the number of car parking available to tenants.

The system shall operate by storing cars and landing calls through a microprocessor based supervisory program. Without calls in the system, cars shall be parked at predetermined floors with one car at the main landing and the other cars evenly dispersed through the building. When landing calls are entered into the system, the program shall gather data from each car in order to determine its current availability for a call and response time. Such data include distance from call, car registered calls direction of travel, car load, etc...

Cars shall be allocated and reallocated to keep the call with the best suited car. Landing calls shall be by-passed but not canceled if car load is approximately 85% of assigned contract load.

If for any reason the car is unable to respond to a landing call, the call shall be transferred to the next car on the result sequence.

It is to be noted here that access to level N-5 is restructed to authorized personnel having special cards. Adequate car readers are to be installed in each car and at the landing of N-5 level to allow such personnel acceed this level. Any push not validated with the card won't be registered and any repetitive attempt will be transferred to the control personnel. The number of cards required is 200.

D. Installation And Tests

Equipment to be factory assembled, at the country of origin, wired and tested. Site work to be limited to installation and assembly of parts dismantled at factory in the country of origin for transportation or otherwise.

Work is to be carried out in a neat, efficient manner in accordance with the requirements of the specifications. Installation to be performed by skilled personnel who are the permanent employment of the authorized dealer.

Equipment installations must be coordinated with the building construction.

Tests are to be carried out in compliance with BS 5655 part10 including free-fall tests, load and speed tests, etc...

A tests certificate is to be issued to the client.