INSTITUTE OF BUSINESS ADMINSTRATION, KARACHI
UNIVERSITY ROAD MAIN CAMPUS, KARACHI

VOLUME - IIA (TECHNICAL SPECIFICATIONS FOR CONSTRUCTION OF GIRLS HOSTEL BLOCK I & II)

1- TECHNICAL SPECIFICATIONS FOR CIVIL WORKS

CLIENT:

IBA Institute of Business Administration Karachi

Leadership and Ideas for Tomorrow

PLANNING & DEVELOPMENT OF PROJECT

I N D E X

A- TECHNICAL SPECIFICATIONS

DIVISION 01 14 00

WORK RESTRICTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1.2 USE OF SITE

A. General:

The Contractor shall have full use of the site of the works, during construction period. However, the Contractor's use of site is limited only by the Employer's right to perform work or to retain other Contractors to do so.

B. Use of Site: Limit work and activities to the area of the Site as defined on Drawings in areas indicated. Do not disturb areas outside the Site or in which the work is indicated.

- Limits: Confine constructions operations to areas where work is permitted.
- The Employer Occupancy: Allow for the Employer occupancy of Site.
- Driveways and Entrances: Keep driveways and entrances serving premises clear and available to the Employer, the Engineer and their employees, other Contractors always engaged in work on the Site and emergency vehicles. Do not use these areas for parking or storage of materials.
- Schedule deliveries to minimize use of driveways and entrances.

- Schedule delivery to minimize space and time requirements for storage of materials and equipment on-site.

C. OCCUPANCY REQUIREMENTS

- **Partial Employer Occupancy:** The Employer reserves the right to occupy and to place and install equipment in completed areas of the Site, before substantial completion, provided such occupancy does not interfere with the Contractor's completion of the Works. Such placement of equipment and partial occupancy shall not, by itself, constitute completion or acceptance, nor Taking-Over of any part of the Works.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not Used)

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DIVISION 01 43 00

QUALITY ASSURANCE – QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1.2 QUALITY ASSURANCE PROGRAM

A. Provide and maintain an effective Quality Assurance Program that complies with Clauses 36, 37, 38 and 39 entitled "Materials, Plant and Workmanship" of the Part I, General Conditions of the Contract.

1.3 SCOPE OF PROGRAM

A. The Contractor shall establish a Quality Assurance Program to perform sufficient inspection and tests of all items of work, including that of his suppliers and subcontractors, to insure conformance to applicable Technical Specifications and Drawings with respect to the materials, workmanship, construction, finish, functional performance, and identification.

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DIVISION 01 32 00

PART – C- CONSTRUCTION PROGRESS DOCUMENTATION

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

B. Refer to Conditions of Contract and Agreement for definitions and specific dates of Contract Time.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Preliminary Construction Program.
2. Construction Program.
3. Submittals Schedule.
4. Daily construction reports.
5. Monthly progress reports.
6. Material location reports.
7. Field condition reports.
8. Accident reports.
9. Special reports.
10. Wage book and time sheet records.

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DIVISION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submitting:

- Shop Drawings.
- Other miscellaneous submittals.

1.3 SUBMITTAL PROCEDURES

A. **General:** Electronic copies of CAD Drawings of the Contract Drawings will not be provided by the Engineer for the Contractor's use in preparing submittals.

B. **Coordination:** Coordinate preparation and processing of submittals with performance of construction activities.

- Transmit each submittal sufficiently in advance of performance of related procurement and construction activities, allowing ample time for review and re-submittal, if necessary, to prevent delays to the Works.
- Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential

activity.

- Coordinate transmittal of different types of submittals for related parts of the Works so processing will not be delayed because of need to review submittals concurrently for coordination.

C. **Processing Time:** Allow enough time for submittal review, including time for re- submittals, as follows. Time for review shall commence on the Engineer's receipt of submittal.

Allow 7 days for processing each submittal.

D. **Identification:** Place a permanent label or title block on each submittal for identification.

- Indicate name of firm or entity that prepared each submittal on label or title block.
- include the following information on label for processing and recording action taken:

- Contract name.
- The Employer's name.
- Date.
- Name and address of the Engineer.
- Name and address of the Contractor.
- Name and address of subcontractor.
- Name and address of supplier.
- Name and address of manufacturer.
- Unique identifier, including revision number.
- Number and title of appropriate Specification Section.
- Drawing number and detail references, as appropriate.

E. **Deviations:** Highlight, encircle, or otherwise indicate and identify on

submittals, deviations from the Contract Documents.

F. **Additional Copies:** Unless additional copies are required for final submittal, and unless the Engineer observes non-compliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

- For submittals requiring concurrent review, submit one extra copy in addition to specified number of copies to the Engineer.
- Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.

G. **Transmittal:** Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form attached to a cover letter. The Engineer will discard, without review, submittals received from sources other than the Contractor.

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DIVISION 01 78 39

RECORD (AS-BUILT) DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Record (As- Built) Documents, including the following:

- Record Drawings.
- Record Specifications.
- Miscellaneous Records.

B. Related Sections include the following:

- Division 1 Section "Summary of Multiple Contracts" for coordinating Project
  Record Documents covering the Work of multiple contracts.
- Division 1 Section "Closeout Procedures" for general closeout procedures.
- Divisions 2 Sections for specific requirements for Record (As-Built) Documents in those Sections.
- Divisions 2 Sections for specific requirements for Miscellaneous Record keeping and submittal in those Sections.

1.3 SUBMITTALS

A. **Record Drawings:** Submit copies of Record Drawings as follows:

1. Initial Submittal: Submit two sets of plots from Record CAD Drawing files and the original marked-up Record Prints. The Consultant will initial and date one set of plots and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. The Consultant will return one set of plots and Record Prints together with review comments, for completing, printing, binding, and final submittal.

B. **Final Submittal**: After incorporating the Consultant's initial submittal review comments, submit:

a. Original marked-up Record Prints set.

b. Sets of (As-Built) Drawings as follows:

- One (1) Set electronic format: (in CD-ROM)
- One (1) set of Mylar reproducible polyester film (Mylar)
- Two (2) bound sets of prints (A2 Size)
- One (1) set of loose copy (blueprint/black line print). Size should be the same as the original Mylar/Polyester films.
- One (1) set of any other document/report about the project, Test results and any other information/documents.

C. **Record Specifications:** Submit two (2) copies of Record Specifications, including addenda and contract modifications.

D. Miscellaneous Records: Submit two (2) sets of original miscellaneous records.

- One (1) set of loose copy (blue print/black line print). Size should be the same as the original Mylar/Polyester films.

- One (1) set of any other document/report about the project, Test results and any other information/documents..

E. **Record Specifications:** Submit two (2) copies of Record Specifications, including addenda and contract modifications.

F. Miscellaneous Records: Submit two (2) sets of original miscellaneous records.

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DIVISION 31 10 00

GRABBING, LEVELLING & GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Conditions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes construction clearing, grubbing, grading, levelling & dewatering.

B. Related Sections include the following:

- Division 1 Section "Temporary Facilities"
- Division 2 Section "Site Clearing."
- Division 2 Section "Earthwork" for excavating, backfilling, and site grading.

1.3 PERFORMANCE REQUIREMENTS

A. CLEARING & GRUBBING :

1. **Scope** : The work shall consists of clearing the designated area of all trees. Down timber, snag bushes & other vegetations, rubbish and other objectionable material and shall include grubbing stumps, roots and matted roots and disposal of all spoil materials resulting from the clearing and grubbing. It shall include the removal and disposal of all structures that protrude encroach upon or otherwise obstruct the work, except when otherwise provided for on the plans or directed by the Engineer to be saved.

2. **Location** : The Engineer will define the limit of areas where clearing and

grubbing is to be done.

3. **Disposal:** All wood and bushes shall be disposed within 15 days after cutting or felling unless otherwise approved.

4. **Protection & Restoration:** The Contractor Shall prevent all damage to pipes, conduits, wires, cables or structures above or below ground. The Contractor shall so control his operations as to prevent damage to trees and shrubs which are to be preserved.

5. **Payment**: the payment shall be made as per BOQ item.

B. **LEVELLING & GRADING:** The work to be done include all earth work to be done with required levels, elevations as marked on drawing or as established by the Engineer .

The work to be done shall be inclusive of performing the required excavation and filling of the area

C. **DE-WATERING:**

- **Dewatering Performance:** Design, provide, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

➢ Work includes removing dewatering system when no longer needed.

➢ Maintain dewatering operations to ensure erosion is controlled, stability of excavations and constructed slopes is maintained, and flooding of excavation and damage to structures are prevented.

➢ Prevent surface water from entering excavations by grading, dikes, etc

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DIVISION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Conditions of Contract apply to this section.

1.2 SUMMARY

This Section includes the following:

1. Preparing and grading sub-grades for slabs-on-grade and pavements.
2. Excavating and backfilling for buildings and structures.
3. Subsurface drainage backfills for walls and trenches.
4. Excavating and backfilling trenches and pits within building lines.
5. Excavation support and protection not otherwise provided for in other sections of the Specification.

1.3 DEFINITIONS

A. **Excavation:** consists of the removal of material encountered to sub-grade elevations and the reuse or disposal of materials removed.

B. **Backfill:** Soil materials 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.

C. **Borrow:** Soil material obtained off-site when sufficient approved soil material is not available from excavations.

D. **Unauthorized Excavation:** Unauthorized excavation consists of removing materials beyond indicated sub grade elevations or

dimensions without direction by the Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, will be at the Contractor's expense.

E. **Structures:** Buildings, footings, foundations, retaining, walls, slabs, tanks, curbs.

F. **Utilities:** Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

G. **Bedding Course:** Layer placed over the excavated sub-grade in a trench before laying pipe.

H. **Fill:** Soil materials used to raise existing grades generally.

I. **Sub-grade:** Surface or elevation remaining after completing excavation, or top surface of a fill or backfill or sub grade layer, immediately below subbase, drainage fill, slab-on-grade, or topsoil materials.

1.4 SUBMITTALS

A. **Pre-construction Records:** Before an excavation is started:

1. Ground levels shall be agreed at suitable intervals with the Engineer.
2. Surface materials and conditions shall be recorded in presence of the Engineer and where appropriate, the Employer or occupiers of the land.
3. The Contractor shall take photographs to illustrate existing damage or conditions, which may prove contentious at the time of reinstatement.
4. This information shall be neatly presented and submitted to the Engineer.
5. Any significant details of any existing natural or piped subsoil drainage

or other underground features shall be identified to the Engineer as work proceeds.

1.5 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 group symbols; free of rock or gravel larger than 75 mm in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. **Unsatisfactory Soils:** ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.

- Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. **Backfill and Fill:** Satisfactory soil materials.

E. **Sub grade Layer:** Satisfactory roadway soil materials, but conforming with the following requirements:

1. Size: 100 percent passing a 75mm sieve and not more than 18 percent passing a 0.075 mm sieve.
2. Organic Matter: Not more than 5 percent; AASHTO T 267.
3. Maximum Dry Density: Not less than 1.7; AASHTO T 180.
4. CBR: Not less than 15 percent; AASHTO T 193.
5. Maximum Plasticity Index: 12 percent.
6. The top 150 mm sub grade material should not contain more than 0.2% total sulphate content and 0.05% total chloride content.

F. **Controlled Fill:** Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; AASHTO M 57; with at least 90 percent passing a 38 mm sieve and not more than 12 percent passing a 0.075 mm sieve.

G. **Bedding:** Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 25 mm sieve and not more than 8 percent passing a 0.075 mm sieve.

H. **Drainage Fill:** Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 38 mm sieve and 0 to 5 percent passing a 2.36 mm sieve.

I. **Filter Material:** Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 25 mm sieve and 0 to 5 percent passing a 4.75 mm sieve.

PART 2 - EXECUTION

2.1 PREPARATION

A. Shore, support and protect buildings, structures, utilities, sidewalks, pavements, and other facilities, on or adjacent to the Project site, from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect sub grades and foundation soils. Provide protective insulating materials as necessary.

C. 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.

2.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared sub grades, and from flooding Project site and surrounding area.

B. Protect sub grades from softening, undermining, washout, and damage by rain or water accumulation.

C. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Install a dewatering system to keep sub grades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

2.3 EXCAVATION SUPPORT AND PROTECTION

A. Design, provide, install, monitor, and maintain at the Contractor's sole risk and responsibility, excavation support and protection systems capable of resisting soil and hydrostatic pressure and supporting sidewalls of excavations.

B. Work includes removing when no longer needed.

C. Install and remove without damaging existing structures, utilities, pavements, and other facilities adjacent to excavations. Install excavation support and protection systems as excavation works proceed, in a manner acceptable to the Engineer.

D. Locate clear of permanent construction to permit access for subsequent construction operations and inspections.

E. Trim excavation as required and fill voids behind with soil, and compact.

F. 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 excavation support and protection remains stable.

G. Remove excavation support and protection systems when construction has progressed sufficiently. Remove in stages to avoid disturbing underlying soils and damaging adjacent structures, utilities, pavements, and other facilities.

H. Promptly repair or replace as directed and approved by the Engineer, adjacent work, structures, utilities, pavements and other facilities, damaged or displaced by installing or removing excavation support and protection systems.

2.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation to sub grade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, boulders, and obstructions.

- If excavated materials intended for backfill, fill, embankment, or sub grade layer include unsatisfactory soil materials and rock, replace with satisfactory soil materials, as applicable.
- Excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other encountered items indicated or directed to be removed; together with other materials not classified as unauthorized excavation; including intermittent drilling, blasting if permitted, ram hammering, ripping and other acceptable means and methods.

- Excavation includes removal and disposal of unsatisfactory soils and any surplus satisfactory soils.

2.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm. Extend excavations a sufficient distance from permanent structures for working space requirements. Place blinding concrete, where indicated, immediately after excavating to final grades.

- Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement or concrete. Trim bottoms to required lines and grades to leave solid base to receive other work.
- Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 25 mm. Do not disturb bottom of excavations intended for bearing surface.

2.6 EXCAVATION FOR PAVEMENTS AND SITE IMPROVEMENTS

A. Excavate surfaces under roadways, parking lots, walks, pedestrian pavements, lawns, planted areas and the like, to indicated cross sections, elevations, and grades.

2.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

- Set out trenches so that they do not encroach below a line drawn at an angle from the horizontal of the nearest lower edge of any adjacent building foundation, as follows:

➢ In Dry Stable Soils: 45 degrees.

➢ In Wet Clays, or Soils below Water Table: 30 degrees.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 300mm higher than top of pipe or conduit, unless otherwise indicated.

➢ Clearance:300mm on each side 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 sub grade 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 sub grade.

- 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 sub grade.
- 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.
- Excavate trenches 150 mm deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. **Trench Bottoms:** Excavate trenches 100 mm deeper than bottom of pipe elevation to allow for bedding course. Remove projecting stones and sharp objects along trench sub grade. Hand excavates for bell of pipe.

- Excavate trenches 150 mm deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

2.8 APPROVAL OF SUBGRADE

A. Notify the Engineer when excavations have reached required sub-grade.

B. If the Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill, fill or sub-grade layer material as applicable, and as directed.

- Additional excavation and replacement material will be paid for according to contract provisions for changes in the Work.

C. Proof rolls expansive sub-grade areas with heavy pneumatic tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated sub-grades.

D. Reconstruct sub-grades damaged by rain, accumulated water, or construction activities, as directed by the Engineer.

2.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by the Engineer.

B. Fill unauthorized excavations under other construction or utility pipe as directed by the Engineer.

2.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrows materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

B. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

2.11 BACKFILL

Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.

2.12 UTILITY TRENCH BACKFILL

A. 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.

B. Backfill trenches excavated under footings and within 450 mm of bottom of footings; fill with concrete to elevation of bottom of footings.

C. Provide 100 mm thick, concrete-base slab support for piping or conduit less than 750 mm below surface of roadways and vehicular pavements. After installing and testing, completely encase piping or conduit in a minimum of 100 mm of concrete before backfilling.

D. Place and compact initial backfill of satisfactory soil material, free of particles larger than 25 mm, to a height of 300 mm over the utility pipe or conduit.

- Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

E. Coordinate backfilling with utilities testing.

F. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

G. Place and compact final backfill of satisfactory soil material to final sub grade.

H. Install warning tape directly above utilities, 300 mm below finished grade, except 150mm below sub grade under pavements and slabs.

2.13 FILL AND EMBANKMENT

A. **Preparation:** Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fill and embankment material.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontals so fill and embankment material will bond with existing material.

C. Place and compact fill and embankment material in layers to required elevations as follows:

- Under footings and foundations, use controlled fill.
- Under building slabs, ramps, and steps, use controlled fill.
- Under roadways and vehicular pavements, use embankment material.
- Under walks and pedestrian pavements, use satisfactory soil material.
- Under lawns and planted areas, use satisfactory soil material.

2.14 MOISTURE CONTROL

A. Uniformly moisten or aerate sub grade and each subsequent backfill, fill or embankment layer before compaction to within 2 percent of optimum moisture content.

- Do not place backfill, fill or embankment material on surfaces that are

muddy.

- 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 density.

2.15 COMPACTION OF BACKFILLS, FILLS AND EMBANKMENT

A. Place soil 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.

B. Place soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact backfills and fills to not less than the following percentages of maximum dry density according to ASTM D 1557:

D. Compact backfills and fills to not less than the following percentages of maximum dry density according to ASTM D 698:

- Under structures, building slabs, ramps and steps, scarify and recompact top 300 mm of existing sub grade and each layer of backfill or fill material at 100 per cent.
- Under walks and pedestrian pavements, scarify and recompact top 150 mm below sub grade and compact each layer of backfill or fill material at 100 per cent.
- Under lawns or unpaved areas, scarify and recompact top 150 mm below sub grade and compact each layer of backfill or fill material at 85 per cent.

2.16 GRADING

A. **General:** Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to

cross sections, lines, and elevations indicated.

- Provide a smooth transition between adjacent existing grades and new grades.
- Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. **Site Grading:** Slope grades to direct water away from buildings and to prevent ponding. Finish sub grades to required elevations within the following tolerances:

- Lawn or Unpaved Areas: Plus, or minus 25 mm.
- Walks and Pedestrian Pavements: Plus, or minus 25 mm.
- Roadways and Vehicular Pavements: Plus, or minus 25 mm.

C. **Grading inside Building Lines:** Finish sub grade to a tolerance of 13 mm when tested with a 3 m straightedge.

2.17 SUBSURFACE DRAINAGE

A. **Subsurface Drain:** Place a layer of drainage fabric around perimeter of drainage trench as indicated. Place a 150 mm course of filter material on drainage fabric to support drainage pipe. Encase drainage pipe in a minimum of 300mm of filter material and wrap in drainage fabric, overlapping sides and ends at least 150mm.

B. Compact each course of filter material to 95 percent of maximum dry density according to ASTM D 1557.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 300 mm of final sub grade. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 150 mm.

D. Compact each course of filter material to 95 percent of maximum dry

density according to ASTM D 1557.

E. Place and compact impervious fill material over drainage backfill to final subgrade.

2.18 DRAINAGE COURSE

A. Under slabs-on-grade, install drainage fabric on prepared sub grade according to manufacturer's written instructions, overlapping sides and ends. Place drainage course on drainage fabric and as follows:

B. Under slabs-on-grade, place drainage course on prepared sub grade and as follows:

- Compact drainage course to required cross sections and thickness to not less than 95 percent of maximum dry density according to ASTM D 1557.
- When compacted thickness of drainage course is 150mm or less, place materials in a single layer.
- When compacted thickness of drainage course exceeds 150mm, place materials in equal layers, with no layer more than 150 mm thick or less than 75 mm thick when compacted.

2.19 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test sub grades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Foundation and Footing Sub grades: At foundation and footing sub grades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing sub grades may be based on a visual comparison of sub grade

with tested sub grade when approved by the Engineer.

D. Testing agency will test compaction of soils in place according to ASTM D 698, ASTM D 1556, ASTM D 1557, ASTM D 2167, ASTM D 2922, ASTM D 2937, ASTM D 4429, and AASHTO T 180, as applicable. Tests will be performed at the following locations and frequencies.

- Paved and Building Slab Areas: At sub grade and at each compacted fill and embankment layer, at least one test for every 200 sq. m or less of each type of paved area or building slab, but in no case fewer than three tests.
- 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.
- Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 50 m or less of trench length, but no fewer than two tests.

E. When testing agency reports that backfills, fills, sub grades, or embankments have not achieved degree of compaction specified, scarify, and moisten or aerate, or remove and replace with satisfactory soil to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. **Protecting Graded Areas:** Protect newly graded areas from traffic, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances were completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

- Scarify or remove and replace soil material to depth as directed by the Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

D. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. **Disposal:**

- Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and dispose of at designated spoil areas on the Employer's property (disposal area will be within a 6-km proximity to the construction area).
- Transport surplus satisfactory soil to designated storage areas on Employer's property. Stockpile or spread soil as directed by the Engineer.
- Remove waste material, including unsatisfactory soil, trash, and debris, and dispose of at designated spoil areas on the Employer's property (disposal area will be within a 6-km proximity to the construction area).

B. MEASUREMENT AND PAYMENT

- The measurement of levelling and grading shall be the net volume excavated between the finished level and the original ground level and no measurement shall be made for fill.
- All costs and charges whatsoever in connection with carrying out the excavation and filling and what soever operation necessary for the proper

and satisfactory execution of the work as specified herein shall be taken as being included in and covered by the rate for and as per quoted in BOQ.

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DIVISION 31 31 16

TERMITE CONTROL

PART 1 – GENERAL

A. General provisions of the Contract, including Conditions of Contract apply to this Section.

1.1 SUMMARY

B. This Section includes the following for termite control:

1. Termite prevention
2. Soil treatment
3. Wood protection

1.2 TERMITE PREVENTION

A. Avoid creation of conditions that invite termites wherever possible. Take the following measures:

1. Remove stumps, roots, wood, and other cellulose materials from the building site before commencing construction.
2. Remove cellulose materials from around the foundation before final backfill.
3. Promptly remove form boards and grade stakes used in construction from site.
4. Allow no contact between building woodwork and soil or fill material.

A. Locate exterior woodwork a minimum of 15 cm above ground and beams in crawl spaces at least 45 cm above ground to provide ample space to make future inspections.

B. Make foundation areas accessible for inspection if possible.

C. If wood that contacts the soil, such as fence posts and foundation elements, use pressure treated wood.

5. Design ventilation openings in foundations to prevent dead air pockets and to help keep the ground dry.

6. Direct water away from the structure through proper grading.

7. Assure that the roof drainage system directs all water away from the foundation.

8. Avoid plantings near the foundation. Any tree that has the potential to grow to a height of 12 meters or taller shall not be planted within 15 meters of the foundation.

1.3 DEFINITIONS

A. EPA: United States Environmental Protection Agency.

B. PMP: Pest Management Professional

1.4 SUBMITTALS

A. Product Data: For termiticide and borate.

- Include the EPA-Registered Label for termiticide and borate products.

B. Product Certificates: For termite control products, signed by product manufacturer.

C. Qualification Data: For Installer of termite control products.

D. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following:

- Date and time of application.
- Moisture content of soil before application.
- Brand name and manufacturer of termiticide.

- Quantity of undiluted termiticide used.
- Dilutions, methods, volumes, and rates of application used.
- Areas of application.
- Water source for application.

E. Wood Treatment Application Report: After application of borate is completed, submit report for Owner's record information, including the following:

- Date and time of application.
- Brand name and manufacturer of borate.
- Quantity of undiluted borate used.
- Dilutions, methods, volumes, and rates of application used.
- Areas of application.
- Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A PMP who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located and who is experienced and has completed termite control treatment like that indicated for this project and whose work have a record of successful in-service performance.

B. Regulatory Requirements: Formulate and apply termiticide, and label with a US EPA registration number, to comply with EPA regulations and authorities having jurisdiction.

C. Document any applicable local codes or authorities and ensure that all relevant work complies.

D. Implement applicable provisions of the Quality Control program as

established in Section 01401, "Contractor Quality Control."

1.6 WARRANTY

A. Warranty: Written warranty, signed by applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, retreat soil and repair or replace damage caused by termite infestation.

B. Warranty Period: Five years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 TERMITICIDES

A. Soil Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or amusable, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation for review and acceptance by the COR.

- The Department of State currently authorizes Thermidor and Premise as soil termiticide.
- Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA Registered Label.

B. Wood Protection Termiticide:

1. Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or mulcible,

concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation for review and acceptance by COR.

2. The Department of State currently authorizes TimBor and BoraCare for preventive wood treatment.
3. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA Registered Label.
4. Protect vegetation from contact with Timbor and BoraCare.

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DIVISION 32 16 00

CONCRETE CURBS AND SIDEWALKS

PART 1 - GENERAL

Drawings and General Provisions of the Contract, including Conditions of Contract and Division 1 Specifications Sections, apply to this Section.

1.1 SUMMARY

This Section includes the following:

A. Pre-cast concrete curbs and units.

Related sections include the following:

A. Division 3: Section 03300 “Cast-in-place Concrete”.

1.2 SUBMITTAL

A. The Contractor shall submit for approval, samples of each of the proposed units together with the manufacturer’s certificates and details of the method of manufacture and materials to be used. The Engineer’s approval of the samples will not be considered final, and the Engineer may reject any pre-cast units delivered to the Site, which do not, in his opinion, meet the required standards.

1.3 QUALITY ASSURANCE

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

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

C. Has sufficient production capacity to produce required units without

delaying the work.

D. Is experienced in manufacturing pre-cast concrete curbs units and tiles similar to those indicated for this project and can demonstrate a record of successful in-service performance.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver pre-cast units to Project Site in such quantities and at such times to ensure continuity of installation. Store units at Project-site in such a way as to prevent cracking or other physical damage.

PART 2 - PRODUCT

2.1 CONCRETE

A. All concrete shall conform with the relevant requirements of Section 03300 - "Cast in-place Concrete" and shall be produced by an approved commercial ready-mix plant. All In-situ and pre-cast concrete shall have 28 days compressive strength on cylinder equal to 21 MPa, except base course and backing concrete which shall be 17 MPa with a maximum aggregate size equal to 60 mm.

B. Mortar shall conform with all relevant requirements of Section 03300 - " Cast-in place Concrete “and shall consist of cement and fine aggregate having the same proportions as that used in the concrete construction.

2.2 REINFORCEMENT

A. Reinforcing steel shall conform with the requirements of Section 03300 Part 2 Products: "Steel Reinforcement".

2.3 PRECAST CONCRETE UNITS

A. All pre-cast units shall be manufactured to the dimensions shown on the Drawings. Manufacturing tolerances shall be 3 mm in any one

dimension. End and edge faces shall be perpendicular to the base.

B. Each pre-cast curb or gutter unit shall normally be 500 mm in length and this length shall be reduced to 250 mm or as directed, where units are to be installed along curves of less than 10 m radius.

C. 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. Bullnoses and curved faces shall be of constant radius with a smooth change from radius to plain face.

D. Surfaces of pre-cast units that will be exposed to view after installation shall be 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. Surfaces that will not be exposed to view after installation shall have all fins and irregular projections removed and all cavities, minor honeycombing and other defects made good with mortar after the units have been saturated with water for at least 3 hours.

E. Pre-cast 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.

2.4 PREFORMED EXPANSION JOINT FILLER

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

2.5 EPOXY ADHESIVE

A. Epoxy adhesive (for use in attaching pre-cast units to existing concrete

pavement surfaces) shall be 2 components epoxy of high viscosity and rapid setting characteristics, conforming to AASHTO M237, Class II.

2.6 DUCTS

A. Ducts (if required under sidewalks or medians) shall consist of uPVC plastic pipe conforming to ASTM D 2750, Type II. If jacking is required, duct shall be approved galvanized steel tube.

2.7 BEDDING

A. Bedding material shall conform to the relevant requirements of Section 02721 - "Aggregate Sub-base Course" for Class A or Class B granular material.

PART 3 - CONSTRUCTION AND INSTALLATION

3.1 CONSTRUCTION AND INSTALLATION

Pre-cast Concrete Curbs:

A. Forms for the concrete base shall be approved wood or steel. 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. If approved, forms for the concrete base may be omitted and the concrete placed directly against undisturbed excavated faces.

B. 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 of 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 pre-cast units are

placed thereon.

C. Pre-cast units shall be soaked in water immediately before installation. Units shall be set accurately in position in mortar on the concrete base. Joints between pre-cast 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.

D. Where curbs or gutters are installed on existing concrete pavement and using epoxy resin adhesive, the installation procedures shall conform with those specified for raised pavement markers in Section 02760 - "Airfield Marking ".

E. After curbs have been installed, steel forms shall be erected and concrete backing, if required, 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.

3.2 ERECTION TOLERANCE

A. Tolerances on tangent sections of curb and gutter shall be tested using a 4 m straightedge. The finished surface of concrete shall not deviate from the straightedge between any 2 contact points by more than 5 mm. curved sections shall be true to the specified radius plus or minus 5 mm and all joints shall be flush and neat in appearance.

B. The area adjacent to completed and accepted curbs and gutters shall be backfilled with approved material to the top edges of the curbs or gutters, or the elevations shown on the Drawings. Backfill shall be placed and compacted to 95% AASHTO T 180 maximum density.

C. The smoothness of paved areas shall be tested using a 4 m

straightedge. The finished surface of concrete shall not deviate from straightedge between any two contact points by more than 5 mm. Sections of defective paving shall be removed and replaced as directed at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

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

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

C. The area adjacent to completed and accepted curbs and gutters shall be backfilled with approved material to the top edges of the curbs or gutters, or the elevations shown on the Drawings. Backfill shall be placed and compacted to 95% AASHTO T180 maximum density. The smoothness of paved areas shall be tested using a 4 m straightedge. The finished surface of concrete shall not deviate from straightedge between any two contact points by more than 5 mm. Sections of defective paving shall be removed and replaced as directed at the Contractor's expense.

3.4 FIELD QUALITY CONTROL

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

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

3.5 REPAIRS

A. Repair pre-cast concrete curbs and tiles to match color, texture, and uniformity of surrounding pre-cast concrete curbs and tiles if permitted by the Engineer.

B. Remove and replace damaged pre-cast concrete curb units and tiles if repairs do not comply with requirements.

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DIVISION 32 14 00

UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Concrete pavers set in aggregate setting bed.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for compacted sub grade and sub base course, if any, under unit pavers.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Concrete pavers.

B. 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 unit paver indicated.

- Include similar samples of material for joints and accessories involving color selection.

C. Samples for Verification: Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.

- Provide samples with joints grouted and cured, showing the full range of colors to be expected in the completed Work.

D. **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/Consultants and owners, and other information specified.

1.4 QUALITY ASSURANCE

A. **Installer Qualifications:** An experienced installer who has completed unit paver 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.

B. **Source Limitations:** Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

C. **Mockups:** Before installing unit pavers, build mockups for each form and pattern of unit pavers 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, including same base construction, special features for expansion joints, and contiguous work as indicated:

- Build mockups in the location and of the size indicated or, if not indicated, as directed by the Consultant.
- Notify the Consultant 7 days in advance of dates and times when mockups will be constructed.
- Demonstrate the proposed range of aesthetic effects and workmanship.
- Obtain the Consultant's approval of mockups before starting unit pavers

installation.

- Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
- Demolish and remove mockups when directed.
- Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.

B. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.

PART 2 - PRODUCTS

2.1 COLORS AND TEXTURES

A. **Colors and Textures:** As shown on drawings and as selected by the Consultant from the manufacturer's full range.

2.2 UNIT PAVERS

A. Concrete Pavers: Solid, interlocking paving units, ASTM C 936, made from normal- weight aggregates in sizes and shapes indicated. Interlocking Paving should be installed on 30-50 mm thick sand setting bed over 250 mm thick sub-base. The minimum thickness of concrete pavers shall be 60mm. Concrete pavers shall be tested for compressive strength, abrasion resistance, absorption, and dimensional tolerance. The test results shall comply with the requirements specified in ASTM C 936.

2.3 ACCESSORIES

A. **Precast Concrete Edge Restraints:** Precast concrete curbing, made from

normal- weight aggregate, in shapes and sizes indicated.

2.4 AGGREGATE SETTING-BED MATERIALS

A. **Graded Aggregate for Subbase:** Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57.

B. **Graded Aggregate for Subbase:** ASTM D 2940, subbase material.

C. **Graded Aggregate for Base:** Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

D. **Graded Aggregate for Base:** ASTM D 2940, base material.

E. **Sand for Leveling Course:** Sound, sharp, washed natural sand or crushed stone complying with gradation requirements of ASTM C 33 for fine aggregate.

F. **Stone Screenings for Leveling Course:** Sound stone screenings complying with ASTM D 448 for Size No. 10.

G. **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.

- Provide sand of color needed to produce required joint color.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with the Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Where pavers are to be installed over waterproofing, examine waterproofing installation, with the 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. Vacuum clean 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. Proof-roll prepared sub grade surface to check for unstable areas and areas requiring additional compaction. Proceed with unit paver installation only after deficient sub grades have been corrected and are ready to receive subbase for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers 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.

For concrete pavers, a block splitter may be used.

D. **Joint Pattern:** Herringbone.

E. Tolerances: Do not exceed 0.8 mm unit-to-unit offset from flush

(lippage) nor 3mm in 3m from level, or indicated slope, for finished surface of paving.

3.4 AGGREGATE SETTING-BED PAVER APPLICATIONS

A. Compact soil sub grade uniformly to at least 95 percent of ASTM D 1557 laboratory density.

B. Place geotextile over prepared sub grade, overlapping ends and edges at least 300 mm.

C. Place aggregate subbase in thickness indicated. Compact by tamping with plate vibrator and screed to depth required to allow setting of pavers.

D. Place aggregate subbase over compacted sub grade. Provide compacted thickness indicated. Compact subbase to 100 percent of ASTM D 1557 maximum laboratory density and screed to depth required to allow setting of pavers.

E. Place 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. Treat leveling base with soil sterilizer to inhibit growth of grass and weeds.

H. Set pavers with a minimum joint width of 1.6 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.

- When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

I. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 16- to 22 kN compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

- After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
- Before ending each day's work, fully compact installed concrete pavers to within 900 mm of the lying face. Cover open layers with non-staining plastic sheets overlapped 1200 mm on each side of the lying face to protect it from rain.

J. 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.

K. Do not allow traffic on installed pavers until sand has been vibrated into joints.

L. Repeat joint-filling process 30 days later.

3.5 REPAIR

Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. 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.

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DIVISION 03 30 00

CAST IN PLACE CONCRETE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

B. Cast-in-place concrete includes, but is not limited to, the following:

1. Foundations and footings.
2. Drilled piers
3. Slabs-on-grade
4. Fill for steel deck
5. Walls
6. Duct banks.
7. Equipment pads and bases.
8. Fill for steel pan stairs.
9. Landscape concrete paving for walkways and bands and Others.

C. The structural concrete elements shall be designed in accordance to the following codes and regulations:

1. 1997 Uniform Building Code.
2. Building Code Requirements for structural Concrete (ACI-318M-02) and Commentary (ACI 318RM-02).

D. The Contractor is to carry out the structural design of the various

project components following the basic design criteria stated in article 1 .2D.

REFERENCES:

American Concrete Institute (ACI):

ACI 117	Specifications for Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 301	Specifications for Structural Concrete for Buildings
ACI 315	Standard Practice for Detailing Reinforced Concrete Structures
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Formwork for Concrete
ACI 504R	Guide to Joint Sealants for Concrete Structures

American Society for Testing and Materials (ASTM):

ASTM A 82	Standard Specification for Steel Wire Reinforcement, Plain, for Concrete
ASTM A 496	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTMA 615M	Standard Specification for Deformed and Plain Billet- Steel Bars for Concrete Reinforcement
ASTMA 706M	Standard Specification for Low-Alloy Steel Deformed and Plain Bars
ASTM A 780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Standard Specification for Concrete Aggregates

ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C 127	Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM C 128	Standard Test Method for Density, Relative Density Specific Gravity) and Absorption of Fine Aggregate
ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

British Standards:

BS 812	Testing Aggregates
BS 882	Specification for Aggregates from Natural Sources for Concrete
BS 1881	Methods of Testing Concrete
BS 1199 and 1200	Specification for Building Sands from Natural Sources
BS 4027	Specification for Sulfate-Resisting Portland Cement
BS 4449	Specification for Carbon Steel Bars for the Reinforcement of

	Concrete
BS 8110	Structural Use of Concrete Part 1 (1997): Code of Practice for Design and Construction, Part 2 (1985): Code of Practice for Special Circumstances, Part 3 (1985): Design Charts for Singly Reinforced Beams, Doubly Reinforced Beams and Rectangular Columns
BS 8666	Specification for Scheduling, Dimensioning, Bending and Cutting of Steel Reinforcement for Concrete
EN 197	Part 1: Cement. Composition, Specifications and Conformity Criteria for Common Cements

1.3 SUBMITTAS

The Contractor's design deliverables should include but not limited to the following:

A. Detailed structural working drawings for concrete items showing the general arrangement, elevations, plans, sections and connection and reinforcement details.

Fully detailed structural calculation showing statical system, computer models, including input file data, using reputable software, and clear graphical illustration of straining actions, deformations along with design of all sections. The design calculations should abide by the design codes and design criteria mentioned in article 1.2D with clear reference to the grade of materials to adopt in the construction in light of the actual availability so that the later substitution are to be restricted.

B. **Steel Reinforcement Shop Drawings:** Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar

schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

C. **Formwork Shop Drawings:** Prepare shop drawings for formwork indicating fabrication and erection of forms for specified finish concrete surface. Show form construction including jointing, especial form joints or reveals, location and pattern of form tie placement. Prepare formwork drawings by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. The Engineer's review is for general architectural applications and features only. Design and engineering of formwork for structural stability and efficiency are the Contractor's responsibility.

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

D. **Product Data:** For proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water stops, joint systems, curing compounds, dry-shake finish materials, and others as requested by the Engineer.

E. **Design Mixes:** For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

F. **Material Test Reports:** From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials.

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

- Cementitious materials and aggregates.

- Form materials and form-release agents.
- Steel reinforcement and reinforcement accessories
- A copy of the manufacturer's test certificate for ultimate strength, elongation and cold bending, together with the chemical analysis of the steel shall be submitted to the Engineer for each consignment of reinforcing steel delivered to the Project site.
- Fiber reinforcement
- **Admixtures:** Material certificates in lieu of material laboratory test reports when permitted by the Engineer. Material certificates shall be signed by the manufacturer and the Contractor, certifying that each material item complies with specified requirements. Provide certification from admixture manufacturers that chloride content complies with specified requirements.
- Water stops.
- Curing materials
- Floor and slab treatments.
- Bonding agents.
- Adhesives.
- Vapor retard ers.
- Epoxy joint filler.
- Joint-filler strips.
- Repair materials

H. **Samples:** Samples of materials as requested by the Engineer, with names, sources, and descriptions, including, but not limited to, the following:

- Color finishes.
- Normal-weight aggregates.

- Water stops, re injectable hosing, water swelling gaskets.

1.4 QUALITY ASSURANCE

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

B. **Codes and Standards:** Comply with 2001 Manual of Concrete Practice Parts 1, 2, 3, 4 & 5, and CRSI "Manual of Standard Practice" except where more stringent requirements are shown or specified.

C. **Concrete Quality Control Engineer:** Appoint a full-time Concrete Quality Control Engineer (CQCE) to ensure that concrete is properly produced, placed, cured and protected.

- The CQCE shall be authorized to:

a. Postpone concreting operations until outstanding requirements are corrected.

b. Reject materials or workmanship that do not conform to this Specification.

c. Prevent the use of equipment that could cause improper construction relative to this Specification.

d. Stop any work that is not being done in accordance with specified requirements.

e. Report within 24 hours and provide records to and as required by the Engineer upon discovery of non-compliance.

D. The Contractor shall operate a Quality Assurance System in accordance with ANSI Q9002. This Quality Assurance Manager shall be responsible for the preparation of a Quality Plan for approval of the operations specified in this Section. The Quality Plan shall include, among other things, the list and schedule of the Quality Control audits that the Quality Assurance Manager or his designee shall make.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

- Avoid damaging coatings on steel reinforcement.
- Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

PART 2 – PRODUCTS

2.1 FORM MATERAIL

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.

1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. **Forms for Unexposed Finish Concrete:** Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

C. **Forms for Textured Finish Concrete:** Units of face design, size, arrangement, and configuration to match the Engineer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

D. **Forms for Cylindrical Columns and Supports:** Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall

thickness to resist wet concrete loads without deformation.

E. **Form Release Agent:** Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs) 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 inhibiters for steel facing materials.

F. **Form Ties:** Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that shall leave no metal closer than 38 mm to the plane of the exposed concrete surface. No permanent metallic part shall have less concrete cover than the reinforcement. Provide ties that, when removed, will not leave holes larger than 25 mm in diameter in the concrete surface. Furnish ties with integral water-barrier plates to walls indicated to receive damp-proofing or waterproofing.

G. **Chamfer Strips:** Wood, metal, PVC, or rubber strips 20mm x 20mm, size as indicated on drawing.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615M, Grade 60 (420 MPa) specified yield strength, or BS 4449 grade 460 Type 2 deformed, uncoated. One test per 5000 m length delivered to site.

B. Plain-Steel Wire: ASTM A 82, as drawn.

C. Only new material shall be furnished. On receipt and at time of installation, material shall be free of loose rust and loose mill scale, deleterious amounts of salts and coatings that reduce or destroy bond. Tight rust and mill scale or surface irregularities are acceptable if the weight and dimensions, including height of deformations and tensile

properties, of a test specimen that has been wire-brushed by hand, are not less than those required by the applicable Standards.

D. Reinforcement shall be accurately bent, cut or formed to the dimensions and configuration shown on Drawings and within the tolerances specified in ACI 315. Reinforcement shall be bent cold using pin sizes in accordance with ACI 318. Bars may be preheated only if prior approval has been requested and received. Reinforcement shall not be recent or straightened without prior approval.

- Reinforcement having a reduced section, kinks, visible transverse cracks at bends, or otherwise damaged in any way shall not be used. Galvanized steel shall not be used for reinforcement.
- Reinforcement shall not be welded unless specifically shown on Drawings or permitted as an exception and then only after approval of the welding method appropriate to the grade of steel and the type of welding rod to be used.

2.3 REINFORCEMENT ACCESSORIES

A. **Bar Supports:** Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

- For concrete surfaces exposed to view where legs of wire bar support contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless- steel bar supports.
- Other reinforcement supports shall consist of concrete spacer blocks made of the same materials, to the same specified requirements and with the same inherent properties as the parent material with the

exception that the maximum aggregate size shall be appropriate for the thickness of cover to the reinforcement.

B. **Joint Dowel Bars:** Plain-steel bars, ASTM A 615M, Grade 60 (420 MPa). Cut bars true to length with ends square and free of burrs.

C. Mechanical Splices (Couplers) of deformed high yield steel bars are to consist of two seamless steel sleeves and interconnecting high tensile steel stud with plastic protection caps for threaded section of sleeve. To be tested and the test to exceed 135% of the specified yield strength of grade 60 bar.

2.4 CONCRETE MATERIALS

A. Portland Cement: Cement shall be low alkali with chemical composition in accordance with Table 1 of ASTM C 150 or EN 197: Part 1. The magnesia content shall be limited to 4 percent by weight of cement, as tested in accordance with ASTM C 114. Use one brand of cement throughout Project unless otherwise approved by the 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 are to be borne by the Contractor, on each delivery of cement to confirm that the cement meets the following requirements.

1. Use Ordinary Portland Cement (OPC) conforming to ASTM C150, Type I. Cement meeting the requirements of rapid hardening Portland cement shall not be used and the heat of hydration shall not exceed 325 kj/kg when tested in accordance with ASTM C 186. C3A content shall be a maximum of 8 percent by weight as tested in accordance with ASTM C 114.

2. Moderate sulphate: According to ASTM C150 type II.

3. Sampling shall be carried out in accordance with EN 196: Part 7.

4. Test cement for fineness by air permeability apparatus in accordance with ASTM C 204 to meet the requirements of ASTM C 150.

5. Test cement for soundness, Autoclave expansion in accordance with ASTM C151.

6. Use white Portland cement in concrete for columns supporting polished precast concrete panel.

B. **Normal-Weight Aggregates:** Aggregates shall be from approved sources and shall conform to the requirements of ASTM C 33 and BS 882. Petrographic analyses shall be made in accordance with ASTM C 295. Aggregates for exposed concrete shall be from a single source and shall not contain substances that cause spalling. Only aggregates not susceptible to alkali aggregate reaction shall be used. The Contractor shall supply samples of the materials for approval by the Engineer and each aggregate source shall be subject to monitoring by the Engineer. Grading of aggregate shall be to the completion of BS 882.

1. **Coarse Aggregate:** Coarse aggregate size shall be 20 mm nominal and those retained on a 5mm sieve and shall consist of crushed or uncrushed gravel or crushed stone and shall be selected, re crushed, finish screened and washed with water meeting the requirements of Paragraph 2.4 as necessary to comply with the following:

Frequency of Tests	Test Description	Standard	Limit
Initial	Los Angeles Loss (Grading A or B)	ASTM C 131	25% max.
1 per day	Clay Lumps and	ASTM C 14	1.0%

	Friable Particles	2	maximum
1 per day	Material Finer than 75 Microns	ASTM C 117	1.0% maximum
1 per 7 days	Water Absorption	ASTM C 127	2.0% maximum
1 per 3 days	Chlorides as Cl	BS 812	0.03% maximum
1 per 3 days	Sulfates as SO3	BS 812	0.3% maximum
1 per 30 days	Magnesium Sulfate Soundness Loss (5 cycles)	ASTM C 88	5.0% maximum
1 per 3 days	Elongation Index	BS 812	25% maximum
1 per 7 days	Specific gravity		Minimum 2.6
1 per 2 days	Moisture Content		

* Additionally, limits specified in Paragraph 2.12.H for the total salt content of concrete shall not be exceeded.

2. **Fine Aggregate**: Fine aggregate, those passing a 5mm sieve, shall consist of crushed gravel, crushed stone, or natural sand with rounded or surrounded particles and shall be washed as necessary to comply with the following:

Test Description	Standard	Limit
Clay Lumps and Friable Particles	ASTM C 142	1.0% maximum
Material Finer than 75 Microns	ASTM C 117	maximum 3% for natural sand and 51 for crushed sand with no plastic fines
Water Absorption	ASTM C 128	1.0% maximum
Chlorides as Cl	BS 812	0.06% maximum
Sulfates as SO3	BS 812	0.30% maximum
Organic Impurities	ASTM C 40	Lighter than Standard

* Additionally, limits specified in Paragraph 2.12 for the total salt content of concrete shall not be exceeded.

3. Certification: Obtain from each proposed source of supply Test Certification to confirm that the aggregates comply with the above requirements. The following information shall be provided:

a. Quarry location.

b. Aggregate type.

c. Petrographic analysis report.

d. Grading curve.

e. Shape and surface texture.

f. Flakiness index.

g. 10 percent fines value.

h. Impact test.

i. Shell content.

j. Chloride and sulfate content.

k. Relative density.

l. Water absorption value and moisture content.

m. Silt, clay, and dust content.

n. Results of reactive silica tests.

o. Organic impurities (fine aggregate only).

4. Testing:

a. When a source of supply for each aggregate type had been established, samples of materials delivered to Project site shall be taken for testing in accordance with BS 812 as follows:

- Tests for clay, silt and dust, and sieve analysis shall be carried out for every 20 tons of fine aggregate and every 40 tons of coarse aggregate.
- Chemical analyses shall be carried out on every 100 tons of aggregate.

b. The Engineer shall have the right to call for additional samples at any time for testing of aggregates delivered to the Project site or of aggregates at the source of supply in order to confirm that the aggregates meet the above requirements.

5. **Transportation:** During transportation to the Project site, all aggregates shall be protected from wind-borne contaminants. If these contaminants are present at time of delivery to the Project site, then the aggregates shall be washed with water meeting the requirement of Paragraph 2.4.F. Transport vehicles shall be cleaned of possible contamination due to previous use.

6. **Storage:** Aggregates shall be stored (under shade) on hard concrete floors or other approved materials having sufficient slope to ensure adequate drainage of aggregate before being used for concrete and each size and type shall be stored in separate heaps without

intermixing. Storage shall prevent contamination of the aggregates by foreign material including windblown dust. Fine and coarse aggregates shall be separated by permanent substantial partitions. Methods of storing, shading and cooling aggregates shall be approved by the Engineer.

7. **Water:** Water used for mixing concrete, ice production, washing and cooling aggregates, and curing concrete shall be free from impurities, oil, acid, salts, alkali, organic matter, and other potentially deleterious substances in accordance with AASHTO T26 and when tested in accordance with ASTM D 512 and ASTM D 516. Additionally, the limits specified in Paragraph 2.12.H for the total salt content of the concrete shall not be exceeded.

- Once a source of satisfactory supply has been established, further tests shall be made daily with a portable electrical conductivity probe calibrated against the satisfactory supply. If the conductivity exceeds that of the satisfactory supply, then further chemical tests shall be performed.

8. **Lightweight Aggregate:** ASTM C 330.

- Nominal Maximum Aggregate Size: 20 mm.

2.5 ADMIXTURES

a. Admixtures containing Chlorides shall not be used.

b. **General:** No admixture shall be used in the concrete without the Engineer's written approval and under no circumstances shall admixtures containing chlorides or other corrosive agents be allowed. Admixture compatibility with the type of cement used shall be proven.

c. The Contractor shall perform a trial batch and casting to substantiate the manufacturer’s claims of workability, retardation and

air entrainment (0 to 1.0 percent maximum), as specified in Article 2.14. Admixtures shall comply with the following standards: ASTM C494/C494 M, EN 934 and EN 480. Also, admixture shall comply with EN 12878 for pigments of cement.

d. **Air-Entraining Admixture:** No air entraining agent shall be used.

e. Admixtures shall be incorporated into the mix design strictly in accordance with the manufacturer's written instructions.

f. **High-Range Water-Reducing Admixture (Superplasticizer):** ASTM C 494, Type G.

- If necessary, and only with the Engineer's approval, a naphthalene sulphonate retarding superplasticizer shall be used to increase workability of the concrete and retard the initial set.
- Products: To produce fluid concrete with a slump value at least 200 mm, easily flowing, but at the same time free from segregation and having the same water/cement ratio as that of a no slump concrete with admixture. The product shall result in concrete that remains workable for a minimum of 3 hours at +20 deg C and for a minimum of 1 hour at +40 degree.
- Obtain from the retarding super plasticizer supplier, details of the material for review by the Engineer and confirmation that it is in accordance with specified requirements. Confirmation shall be obtained that the retarding super plasticizer is compatible with any pozzolan that is used.
- Glare-Reducing Agent: For landscape concrete paving, provide material for reducing glare. Comply with ASTM D 209.

g. **Water-Reducing Admixture (Plasticizer):** ASTM C 494, Type

h. **Water-Reducing and Accelerating Admixture:** ASTM C 494, Type E.

i. **Water-Reducing and Retarding Admixture:** ASTM C 494, Type D.

j. **Corrosion-Inhibiting Admixture:** Commercially formulated, mixed cathodic and anodic inhibitor based on Amines and Alcohol; capable of forming a protective barrier and absorbed on the reinforcement surface of concrete for protecting steel bars and minimizing chloride reactions with steel reinforcement in concrete.

2.6 WATERSTOPS

a. **Waterstops:** Provide flat, waterstops at construction joints below earth level and or for water structures and other joints. Waterstops shall be sized to suit joints.

- Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricates corners, intersections, and directional changes.
- Select profile from five subparagraphs below. Insert others if required.
- Profile: Flat, dumbbell with center bulb.
- Profile: Flat, dumbbell without center bulb.
- Profile: Ribbed with center bulb.
- Profile: Ribbed without center bulb.
- Profile: As indicated.

b. **Fine-Graded Granular Material:** Clean mixture of crushed stone, crushed gravel, and manufactured of natural sand; ASTM D 448, Size 10, with 100 percent passing a 4.75 mm sieve and 10 to 30 percent passing a 0.15 mm sieve; meeting deleterious substance limits of ASTM C 33 for fine aggregates.

c. **Sand Cushion:** Clean, manufactured or natural sand.

d. **Absorptive Cover:** Burlap cloth made from jute or kenaf weighing approximately 0.29 kg/sq. m and complying with AASHTO M182, Class 2.

e. **Moisture-Retaining Cover (Impervious Sheeting):** One of the following, complying with ASTM C 171:

- Waterproof paper.
- Polyethylene film.
- Polyethylene-coated burlap.

f. **Evaporation Control:** Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

g. **Colored Wear-Resistant Finish:** Packaged dry combination of materials consisting of Portland cement, graded aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground non-fading mineral oxides interground with cement. Color shall be as selected by the Engineer from manufacturers' standards, unless otherwise indicated.

2.7 REPAIR MATERIAL

a. **Repair Underlayment:** 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.

- Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
- Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.

b. Aggregate: Well-graded, washed gravel, 3 to 6 mm or coarse sand as recommended by underlayment manufacturer.

c. Compressive Strength: Not less than 30 MPa at 28 days when tested according to ASTM C 109M.

d. **Repair Topping:** Traffic-bearing, cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 6 mm.

- Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
- Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
- Aggregate: Well-graded, washed gravel, 3 to 6 mm or coarse sand as recommended by topping manufacturer.
- Compressive Strength: Not less than 40MPa at 28 days when tested according to ASTM C 109M.

2.8 CONCRETE MIXES

a. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:

- Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- Proportion lightweight structural concrete according to ACI 211.2 and ACI 301.

b. Use a qualified independent testing agency acceptable to the Engineer for preparing and reporting proposed mix designs for the laboratory trial mix basis.

- Do not use the same testing agency for field quality control.

c. Submit written reports to the Engineer of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed and approved by the Engineer.

d. Design mixes to provide normal-weight concrete with the following properties unless otherwise indicated on Drawings:

e. Blinding Concrete: Proportion normal-weight concrete mix as follows:

- Compressive Strength (28 Days): 14MPa.
- Maximum: water cement ratio: 0.55.

f. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:

- Compressive Strength (28 Days): 40 MPa
- Maximum water cement ration: 0.4

g. Slab-on-Grade: Proportion normal-weight concrete mix as follows:

- Compressive Strength (28 Days): 30 MPa.
- Maximum water cement ratio:0.40

h. Light-weight concrete for topping steel deck: Proportion light-weight concrete mix with maximum specific gravity (1800 kg/cu.m) as follows:

- Compressive Strength (28 Days): 30 MPa.
- Maximum water cement ratio: 0.4
- Minimum cement content: 350 kg/cu.m.

2.9 Cement Content:

1. Structural concrete shall contain a minimum of 355 kg/cu. m of Ordinary Portland Cement (OPC) plus silica frame if needed. All concrete below ground shall have protective coating as specified.
2. Blinding/mudmat concrete shall contain sufficient OPC to obtain the specified design strength.

2.10 Water-Cement Ratio: The free water-cement ratio shall not exceed 0.40. The water-cement ratio shall be the water content divided by the cement. 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 as specified.

2.11 Slump Limits: The slump of concrete mixes shall be such that the concrete can be transported, placed into the forms, and compacted without segregation in accordance with Article 3.8. If no superplasticizer is required, the slump at time of placement shall be 50-75 mm as measured in accordance with ASTM C 143.

2.12 Total Salt Content:

1. Chlorides: The total chloride content (sum of both acid soluble and water soluble chlorides) of the concrete from all sources, expressed as chloride ion, shall not exceed 0.15 percent by weight of dry cement, when tested in accordance with BS 1881.
2. Sulfates: The total sulfate content of the concrete from all sources, expressed as SO3, when tested in accordance with BS 1881, shall not exceed 3 percent by weight of dry cement

2.13 Initial Setting Time:

1. The initial setting time shall be not less than one hour after the production concrete is discharged into the form. With a maximum time between mixing and placing concrete of one hour, the total time between mixing and initial set shall be a minimum of 2 hours. There shall be a maximum setting time of 6 hours.
2. When trial mixes are made to determine the workability of the concrete, the initial setting time of the cement paste shall be determined using the method defined in ASTM C 191 but at the maximum allowable temperature and with same proportions of retarding superplasticizer as specified in this Specification.

2.14 Test Construction:

1. Test Foundation: A test foundation footing and plinth shall be cast on grade to the details provided by the Engineer in

accordance with specified requirements. This shall be performed before any permanent works are constructed. The concrete shall be cured for the period required in Article 3.13, after which an epoxy coating shall be applied to that part of the plinth which would normally be above ground and a bitumen coating applied to the remainder of the plinth and the footing, all in accordance with Article 3.17.

2. Test Floor Slab: A 3 m by 4 m test area of 150 mm thick floor slab constructed of above ground reinforced concrete in accordance with this Specification shall be cast on grade and given a Class U4 finish as specified in Paragraph 3.11.E. The concrete shall be cured for the period specified in Article 3.13.

A. **Cementitious Materials:** Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:

1. Silica fume: 5%

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

C. Admixtures: Use admixtures according to the manufacturer's written instructions.

1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious

materials ratio below 0.50.

A. All to be as required and approved by the Engineer, for placement and workability. Use admixtures in accordance with the manufacturer's instructions. Ensure that the correct quantity of admixture is always used. The equipment to be used for dispensing and the method of incorporating the admixture into the concrete shall be subject to approval. The dispensing unit shall be translucent so that the operator can see the discharge of the admixture.

2.15 FABRICATING REINFORCEMENT

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

2.16 CONCRETE MIXING

A. **General**: Concrete production shall be in accordance with ACI 304. A checklist for concrete production shall be produced, such as that used by the NRMCA or approved equal.

1. Batching of materials shall be by weight. All weighing equipment shall be calibrated and documentation shall be provided to establish that the accuracy is continuously maintained in accordance with the requirements of ACI 304. Batching scale accuracy shall be in accordance with the Concrete Plant Standards of the Concrete Plant Manufacturers Bureau or approved equal.

2. Furnish the necessary equipment and establish accurate procedures for determining the quantities of free moisture in the aggregates. Moisture determinations shall be made daily and whenever there is an apparent change in the moisture content. The moisture content shall be recorded. The moisture of aggregates shall be utilized in adjusting the weight of aggregate added to the mix. The water added to the mix shall be similarly adjusted.

B. **Job-Site Mixing:** All concrete mixed on Project site shall be in a batch mixer of approved size and design complying with ACI 304 and producing a uniform distribution of the materials throughout the mixed concrete in accordance with ASTM C 94 uniformity test. The contents of the drum shall be completely discharged before re-charging. After all the materials are in the mixer, mixing shall continue until the whole of the materials are uniformly distributed and the mass is of uniform color and consistency. In the case of concrete that contains silica fume with a density between 400-650 kg/cu. m, the mixing time shall be 50 percent greater than the requirement for concrete without silica fume.

1. Whenever mixing is to be suspended for half an hour or longer, the drum of the mixer shall be thoroughly washed out with clean water. Provide a competent operator who shall be in continuous control of the mixer. No retempering of concrete, which has partially hardened, by the addition of cement, aggregate, or water shall be allowed.

   Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

D. MIXED CONCRETE

1. Ready-Mixed concrete shall comply with the requirements of ASTM C 94 or BS 5328 and as follows:

- Concrete shall be centrally mixed off site and transported in an agitator truck. Truck mixing shall not be permitted.
- The plant and trucks shall be certified as meeting the requirements of the NRMCA Check List or approved equal.
- Details and information regarding the supplier proposed by

the contractor shall be submitted to the Engineer for approval.

- The sewer of ready mixed concrete shall not subsequently be charged without further approval of the Engineer

2. When air temperature is between 30 deg.C and 32 deg.C, delivery time from the time water is added to the mix until it is placed in its final position in the form shall not exceed 60 minutes. When air temperature is above 32 deg.C, delivery time shall not exceed 45 minutes.

3. Before discharging concrete at the point of delivery, provide the Engineer with a delivery ticket for each batch of concrete containing the following information as a minimum:

- Name or number of off-site concrete depot.
- Serial number for ticket.
- Date.
- Time of dispatch.
- Truck number.
- Name of Supplier.
- Grade or mix description of concrete.
- Type of cement.
- Cement content.
- Water/cement ratio.
- Nominal maximum size of aggregate.
- Source of aggregate, maximum size, weight of fine and coarse aggregate.
- Type or name of admixture, if included.
- Quantity of concrete in cubic meters.
- Certifying that chlorides and sulfate contents are within specified

limits and stating their values.

- Amount of concrete in cubic meter

PART 3 - EXECUTION

3.1 FORMWORK

- 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 concrete structure can support such loads. Design of formwork shall be the sole responsibility of the Contractor.
- Construct formwork so that concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
- Class A, 4 mm.

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

B. 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. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

C. Do not use rust-stained steel form-facing material.

D. 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.

E. 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.

F. Chamfer exterior corners and edges of concrete receiving applied waterproofing membranes.

G. Do not chamfer corners or edges of concrete unless otherwise indicated.

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

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

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

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

L. Where it is required to use internal ties and spacers, their type, spacing and use shall be to the, approved of the Engineer. In no circumstances shall these ties protrude out of the finished concrete, all ties must be cut back into the structural concrete and the surface made good to satisfy the requirements of the minimum spacing and cover.

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.

- Install anchor bolts, accurately located, to elevations required.
- Install reglets to receive top edge of foundation sheet 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.
- Install dovetail anchor slots in concrete structures as indicated.

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 provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. The Engineer shall be notified when the Contractor intends to remove any formwork at least 6 hours prior to starting the process.

C. Leave formwork, for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved the following:

- 28-day design compressive strength.
- At least 70 percent of 28-day design compressive strength.
- Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.
- Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

D. 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.

E. 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 318M, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.

B. Plan sequence of removal of shores and reshore to avoid damage to concrete.

C. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

A. **Vapor Retarder:** Place, protect, and repair vapor retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

B. **General:** Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.

C. Lap joints 150 mm and seal with manufacturer's recommended mastic or pressure- sensitive tape. Cover vapor retarder/barrier with sand cushion and compact to depth indicated.

3.6 STEEL REINFORCEMENT

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

1. Avoid cutting or puncturing vapor retarder/barrier and waterproofing membranes during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. 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. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.

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

D. Install welded wire fabric 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.

E. Shipping and Storage:

1. Reinforcement shall be handled and shipped in a manner to avoid bending or other damage to the bars. Bars shall be bundled, separated in sizes and clearly marked by diameter size preferably for one placement, in accordance with the placement schedule and as follows:

a. Bars for separate buildings or large structures shall not be bundled together. Bars for small structures may be bundled together but each bar or group of bars that have the same piece mark shall be tagged and coded.

b. Metal tags or approved equal shall be provided and labeled with legible markings.

c. All bundles shall be tagged at each end. Tags shall show piece marks corresponding to the mark numbers on the placement drawings and on the bar list.

d. Bars shall be bundled in the largest size practical for handling and shipping.

2. Reinforcement shall be stored 1m above ground on platforms, skids or other approved supports and suitably spaced. Contact with the soil shall be avoided. Proper drainage and protection from the elements shall be provided to minimize corrosion.

F. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

G. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement on concrete blocks of a size to give the correct cover to the reinforcement. Concrete spacer blocks shall be made of the same materials, to the same specified requirements and have the same inherent properties as the parent material, but with the exception that the maximum aggregate size shall be appropriate for the thickness of cover to the reinforcement.

1. Chairs made of reinforcement shall be used to support the top mats of slab reinforcement and they shall be so dimensioned as to be stable during concreting operations. The chairs shall themselves be supported on concrete blocks as specified above.

H. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Ties at intersections shall be made with 1.5 mm diameter annealed wire with wire ends directed into concrete, not toward exposed concrete surfaces.

I. Concrete Cover:

1. Concrete cover to reinforcement shall be as indicated on Drawings but shall not be less than the following:

a. Cover for all concrete below grade and waterproofed shall be 50 mm.

b. Cover for all other exterior exposed concrete faces shall be 50 mm.

c. Cover for all other interior protected faces shall be 40 mm, except slabs which shall be 25 mm.

2. Cover to reinforcement shall be checked before any concrete is cast. The bending of reinforcement at a cold joint is not permitted. Concrete cover shall be checked with a cover meter as soon as formwork is removed.

J. All lap splices shall be in accordance with ACI 318 class B tension lap splice unless otherwise shown on Drawings. All reinforcement bars shall be developed in accordance with ACI 318 unless otherwise shown on Drawings. Welded wire fabric shall be lapped 1.5 mesh plus the extension on the wires unless otherwise shown on Drawings.

3.7 JOINTS

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

B. Construction Joints.

1. Locate and install construction joints so that they do not impair strength or appearance of the structure and are acceptable to the Engineer. Unless otherwise shown or approved, provide and locate construction joints in accordance with ACI 301. Where construction joints are indicated in construction documents, no deviation shall be allowed without the approval of the Engineer. Additional joints shall be kept to a minimum and must be approved by the Engineer. The joint surface shall be roughened to remove laitance without disturbing the coarse aggregate by pressure jetting with air and water or by wire brushing. The joint shall be clean prior to placing fresh concrete. The

new concrete shall be well worked against the old concrete to ensure a good joint.

2. The use of expanded metal or other perforated material is prohibited in construction joints.

3. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.

4. 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.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders.

6. Space vertical joints in walls as indicated, or as required by the Engineer.

7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

8. Waterstops: Provide waterstops in construction joints. Install waterstops to form a continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to the manufacturer's printed instructions.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:

1. 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.

2. 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.

D. 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.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface.

2. Terminate full-width joint-filler strips not less than 12 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.

E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.

1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

F. Score Joints for Landscape Concrete Paving: As shown on Drawings.

G. Unless otherwise indicated on design drawings, joint sealing shall be in accordance with ACI 504R.

3.8 WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into

place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

A. **General:** Comply with ACI 301, ACI 304, and ACI 318.

B. **Inspection:** Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work. Concrete shall not be placed until the condition of the reinforcement, other embedded items, and the formwork has been inspected and approved by the Engineer.

C. **Transportation:** Concrete, after being discharged from the mixer, shall be transported as rapidly as possible to its final position in the Work by agitator trucks, which shall prevent adulteration, segregation, loss of workability or contamination of the ingredients. The containers that convey the concrete shall be kept clean and free from hardened or partially hardened concrete.

1. The addition of water at the point of discharge is prohibited and trucks shall have the water tank completely disconnected from the drum.
2. The use of chutes, spouts, skips and pumps shall be permitted if approval is obtained. Under no circumstances shall any aluminum pipe or other conveying equipment containing aluminum be allowed to contact fresh concrete when it is conveyed to its point of placement.
3. Method of pouring and pouring sequence shall be submitted by the Contractor to the Engineer's approval.

D. **Placing Concrete in Forms:** Deposit concrete in forms continuously or in horizontal layers no deeper than 450 mm and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while the preceding layer is still plastic to avoid cold joints. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

1. Concrete shall not be dropped into place from a height exceeding 1.5 m nor through dense reinforcing steel, which could cause segregation of the coarse aggregate. Structural concreting against open excavation will not be permitted as the concrete cannot be coated afterwards.
2. When vertical lifts of concrete are interrupted or delayed for more than one hour, the surface of the unfinished concrete shall be thoroughly cleaned and washed with cement grout immediately before fresh concrete is added and the first layer of new concrete placed shall not exceed 150mm depth and particular care shall be taken with compaction of this new layer to ensure good bond.
3. Method of pouring and pouring sequence shall be submitted by the Contractor to the Engineer's approval.

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

F. Deposit concrete continuously or in 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 specified. Deposit concrete to avoid segregation.

G. Deposit concrete in forms in horizontal layers no deeper than 600 mm and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.

1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than

the visible effectiveness of the vibrator. Place vibrators 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 mix constituents to segregate.

H. 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 that 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, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

I. **Compaction and Vibration:** Full compaction of the concrete shall be achieved throughout the entire depth of the layer. It shall be thoroughly worked against the formwork and around the reinforcement and successive layers shall be thoroughly bonded together. Air bubbles formed during the mixing and casting shall be expelled particular care shall be taken where sloping formwork is used.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with

ACI 309.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators 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 set. At each insertion, avoid over vibration and limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

J. **Placing Concrete Slabs:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations. Maintain reinforcing in proper position during concrete placement.

K. **Hot-Weather Placement:** When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 25 deg.C. Mixing water may be chilled 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 the Contractor's option.

2. Concrete temperature shall not exceed 32 deg. C and the temperature differential shall not exceed 25 deg. C.
3. No concreting operation shall be carried out at ambient temperature of 40 deg. C or more.
4. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
5. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
6. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to the Engineer.
7. Shade mixing plant and trucks, aggregates, water tank, and cement silo.
8. Paint white the mixing plant, trucks, water tank, and cement silo.
9. Insulate the water tank and supply piping.
10. 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).
11. Concrete placing shall be completed as quickly as possible to reduce transit time.
12. Curing of exported concrete shall be immediately carried out.

3.10 FINISHING FORMED SURFACES

A. **Rough-Formed Finish (Class F1):** Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. Concrete surface texture is that imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 7 mm in

height rubbed down or chipped off. This finish class is not applicable to elements where backfill is to be placed against the concrete.

B. **Smooth-Formed Finish (Class F2):** Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, such as waterproofing, damp-proofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed. No ledges shall be permitted at the position of joints in the formwork.

C. **Smooth-Rubbed Finish (Class F3):** Provide smooth-rubbed finish not later than 1 day after form removal on scheduled concrete surfaces that have received smooth- formed finish treatment. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. **Grout-Cleaned Finish (Class F4):** Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.

1. Combine one part Portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement in amounts determined by trial patches so that final color of dry grout shall match adjacent surfaces.

2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean

burlap. Keep damp by fog spray for at least 36 hours after rubbing.

3.11 FINISHING FLOORS AND SLABS

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

B. **Scratch Finish (U1):** Apply scratch finish to monolithic slab surfaces receiving concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured in accordance with ASTM E 1155M. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

C. **Nonslip Broom Finish (U2):** Apply a nonslip broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

D. **Float Finish (U3):** Apply float finish to monolithic slab surfaces receiving trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or

both. Consolidate surface with power- driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured in accordance with ASTM E 1155M. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

E. **Trowel Finish (U4):** Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film finish coating system. This finish is also applicable to tops of buried foundations since they have to be subsequently coated.

1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances in accordance with ASTM E1155M of the following:

a. Specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15.

b. Specified overall values of flatness, F(F) 35; and levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17; for slabs-on-grade.

c. Specified overall values of flatness, F(F) 30; and levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and levelness, F(L) 15; for suspended slabs.

d. Specified overall values of flatness, F(F) 45; and levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and levelness, F(L) 24.

2. Grind smooth any surface defects that would telegraph through applied floor covering system.
3. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 3 m long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
    a. 7 mm.
    b. 5 mm.
    c. 3 mm.

F. **Trowel and Fine Broom Finish (U5):** Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

G. **Colored Wear-Resistant Finish (U6):** Apply a colored wear-resistant finish to monolithic slab surface indicated.

1. Apply dry shake materials for the colored wear-resistant finish at a rate of 5 kg/sq. m, unless a greater amount is recommended by material manufacturer.
2. Cast a trial slab approximately 3 m square to determine actual application rate, color, and finish, as acceptable to the Engineer.
3. Following placement, vibrating and leveling, float the concrete with a wooden float to “open” the surface and allow the excess moisture and air to escape.
4. Once the sheen has disappeared, apply floor hardener as a dry shake onto the wet surface. Apply approximately one-half of the material and then float into the surface with a wooden float.
5. Following the first float, apply the balance of the material and float in the same fashion.
6. Once the surface is firm enough to take foot traffic, use a power float to

finish the surface to a smooth and non-slip finish.

7. After floating, apply a trowel finish as specified. Cure slab surface with a curing compound recommended by the dry shake material manufacturer. Apply the curing compound immediately after the final finishing.

3.12 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 Work.

B. **Curbs:** Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. **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 of manufacturer furnishing machines and equipment.

D. **Steel Pan Stairs:** Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

E. Tolerance and concrete dimensions for in-situ concrete members shall, under no circumstances, exceed the permissible ones as indicated in the ACI.

3.13 CONCRETE PROTECTION 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 with recommendations in ACI 305R 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 by one or a combination of the following methods:

D. **Unformed Surfaces:** Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, 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 recommends for use with floor coverings.

E. **Curing Methods:** Cure concrete by curing compound, by moist curing, by moisture- retaining cover curing, or by combining these methods, as specified below.

1. Horizontal Surfaces: Horizontal surfaces shall be saturated with water and then treated with curing compound. Apply curing compound as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. The surfaces shall then be bonded and flooded with water or draped with wet burlap together with a perforated soaker hosepipe, covered with white impervious sheeting held firmly in place along all edges and kept continuously wet for the duration of the curing period.

2. Vertical Surfaces: Vertical timber formwork shall be draped with wet burlap as soon as concrete is placed. Vertical surfaces shall be treated with curing compound as soon as formwork is removed, draped with wet burlap, covered with white impervious sheeting held firmly in place along all edges and kept continuously wet for the duration of the curing period. Care shall be taken to avoid drying winds.

3. Impervious Sheeting: Impervious sheeting shall be in accordance with ASTM C 171.

3.14 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

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

C. Install semi-rigid epoxy joint filler full depth in saw-cut joints and at least 50 mm deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

A. Concrete exposed by the removal of formwork shall be inspected by the Engineer before any remedial work, subsequent coating or other treatment that would hinder the proper inspection of the concrete is carried out. Any concrete not complying with this requirement shall be liable for rejection.

B. Concrete not meeting the specified requirements shall be removed and rebuilt without delay unless the Engineer approves that a repair may be satisfactorily affected. This agreement shall not preclude the subsequent rejection of the repaired work by the Engineer. The proposed method for removal and replacement of defective work shall be submitted to the Engineer for approval for each concrete placement before the removal commences.

C. All repairs approved by the Engineer shall be performed by a subcontractor specialized in the repair of concrete in the Middle East

and prepared to guarantee the work. Any repair method submitted for approval shall produce a result that is as impermeable as the original concrete. Subsequent tests on the repaired concrete shall be carried out at the discretion of the Engineer in order to establish the quality of the repair, particularly at the joint between the original and the repaired concrete.

D. **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.

E. **Patching Mortar:** Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a 1.2 mm sieve, using only enough water for handling and placing.

F. **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.

G. **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, pop outs, honeycombs, rock pockets, crazing and cracks in excess of 0.25 mm wide or that penetrate to reinforcement or completely through un-reinforced 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 20 mm clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix 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.

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

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

3.16 CONCRETE PROTECTION - RAFT, FOUNDATION, WALLS, COLUMN NECKS AND OTHER BURIED STRUCTURES

A. All foundations, rafts, pile caps, strap and tie beams, column necks, etc., in contact with the soil or binding shall be protected by one layer of non-reinforced SBS (20%) modified membrane as specified below.

B. The blinding and concrete surfaces to which the membrane is to be applied shall be clean, smooth, dry, free of fins, sharp edges, loose and

foreign materials, oil and grease.

C. All imperfections, depressions, hollows, etc shall be made good and prepared to receive the tanking/water proofing membrane.

D. Cement sand fillet 50 x 50 mm shall be provided at all internal corners and all external corners shall be chamfered to provide smooth transition.

E. The shoring system wall shall be shotcrete and if need be plastered to obtain an even, smooth surface for the application of tanking as recommended by the applicator and as approved by the Engineer. After the shotcrete/plaster has cured and dried for at least 3 days, the surface shall be cleaned of all grease, oil, dust, loose material, etc and shall present a sound and smooth surface in one straight plane, free of any sharp protrusions or depressions and any extraneous matter.

F. The horizontal membranes shall be protected by a layer of slip-sheet of minimum 200 gm/m2 and a layer of cement sand screed of minimum 30 mm thickness against damage from reinforcement and site traffic. The area of the membrane laid at any one time should not exceed that which can be protected by screed in the same period. Care should be exercised in the sequence of laying screed to ensure that the membrane laid is damaged due to site traffic or other trade works or any other cause.

G. The membrane laid vertically shall be protected by a continuous wall of extruded polystyrene boards 25 mm thick spot bonded all along the edges and the centre of the boards to the membrane as recommended by the manufacture and/or as directed by the Engineer to prevent any damages from wall reinforcements and formwork.

H. Extreme care shall be taken not to damage the membrane during the erection of reinforcement steel and shuttering for wall. The area

of the membrane/polystyrene that is outside the limits of concrete shall be protected as approved by the Engineer.

I. A layer of 3 mm thick sand cement screed for horizontal layers and a layer of Protection board for vertical layers shall be used to protect the membrane from damage against back filling for all foundation members other than the basement walls (which shall be protected as detailed above).

J. The priming of the surfaces, the laying of the membrane, laps and joining of the membrane and application shall be as per the recommendations of the manufacturer and to the approval of the Engineer.

K. The treatment/termination of the membrane at the top most position above ground level shall be as recommended by the applicator and subject to the approval of the Engineer.

L. Alternative waterproofing systems may be submitted to the Engineer for review and approval. Submittal shall include technical data and case histories sufficient for the Engineer to do a technical evaluation of the proposed systems.

M. Install membrane system in accordance with the membrane manufacturer's instructions.

N. Submit the following to the Engineer for approval before beginning the work:

1. List of all membrane materials, joint compounds, and concrete surfaces to be used in the Work. List shall identify the specific products by manufacturer and catalog number.

2. Procedures for material storage and handling, surface preparation, environmental control, application sequence, overlap dimensions, touch-up and repair, curing, and inspection of the

membrane system. The membrane manufacturer's published instructions and installation details shall be attached as part of submitted procedures. Conflicts between the material manufacturer's recommendations and Contract Documents shall be noted in writing to the Engineer for resolution.

3. Cleaning and installation verification forms for daily inspection records. A detailed cleaning and installation verification report in accepted form shall be completed each day during the work and submitted for record. The final verification report shall include a statement of completion conformance verifying that the required materials were used and that the accepted application procedures and specified requirements were followed.

4. Details concerning corners, bottom slab to wall tie-ins, slab/wall/roof penetrations, terminations, control joints, expansion joint, and crack control.

5. Manufacturer material safety data sheets for all materials used in the execution of the work.

O. Arrange for the material manufacturer's technical representative to be present at the beginning of work and to qualify installation personnel in the installation of the manufacturer's waterproofing products.

P. **Joints:** Unless otherwise shown on design drawings, joints shall be designed and constructed in accordance with ACI 504R. Details and positioning of joints, together with the materials to be used, shall be submitted for the Engineer's approval.

1. Waterstops shall be in accordance with Paragraph 2.8A. Jointing of waterstops shall be made by welding in an approved fashion. Lapping of waterstops at joints and the use of adhesives for jointing

purposes will not be permitted unless approved by the Engineer. Waterstops shall not be perforated or damaged. Concrete shall be carefully placed and compacted to ensure dense impervious concrete, particularly around the ribs of waterstops. At all joints except for expansion joints as indicated on Drawings, the concrete shall be placed up to the centerline of the waterstop. All starters to walls of watertight construction shall be cast using hung formwork so that the concrete in the starters is placed simultaneously with the concrete in the slab

3.17 GROUTING

A. **Preparation:** Concrete foundation top shall be cleaned of dirt, laitance, oil and grease. Anchor bolt boxes and sleeves shall be cleaned of all polystyrene and other deleterious material. The surface of the concrete shall be thoroughly wetted just prior to grouting but shall contain no excess water, particularly in the bolt boxes and sleeves.

B. Materials:

1. Type G1: For interior bases protected from weather and saline bearing waters and not subject to heavy or vibratory loads, grout shall consist of one part Portland cement to two parts well graded sand by volume. Sand shall comply with Paragraph 2.5.C.2.A retarding superplasticizer may be used if necessary to obtain the correct fluidity in high ambient temperatures.
2. Type G2: For all heavily loaded structural column bases and equipment bases subjected to vibratory loads, a proprietary non-shrink, non-metallic high strength grout especially formulated for high-temperature work.
3. Type G3: For all other exterior work exposed to potential saline ingress, a proprietary general purpose non-shrink grout, especially

formulated for high temperature work.

C. Placement:

1. The manufacturer's recommendations shall be followed for proprietary grouts. The temperature of the grout at time of placement shall not exceed 25 deg.C (77 deg. F) and the temperature of the elements in contact with the grout shall not exceed 40 deg.C (104 deg. F) . To obtain the required temperatures, it may be necessary to do the following:

a. Shield the materials from the direct rays of the sun.

b. Mix materials with flaked ice.

c. Cool base plates with water but ensure that anchor bolt pockets are free from water.

d. Require certification of plant and trucks to meet requirements

2. Grout strength shall not be less than 30 N/sq.mm at 28 days. Document to Engineer that this strength is being achieved. Grouting shall not proceed until the steel work or equipment has been leveled and plumbed with the bases being supported in the meantime by steel packers and shims.

3. Completely fill anchor bolt sleeves with grout before placing grout under base plates. The gravity grouting method shall be used wherein the flowable self- leveling grout is poured on one side of a base until it flows out at the opposite side. Packers and shims used to level bases shall be removed after the grout has set and the resulting pocket repaired with similar grout.

3.18 WATER-RETAINING CONSTRUCTION

A. **General:** Water-retaining construction shall comply with this Specification.

B. **Joints:** Joints shall be designed and constructed in accordance with

ACI 504R. Details and positioning of joints, together with the materials to be used, shall be shown on the Drawings.

1. Water stops shall be in accordance with Paragraph 2.6.A. Jointing of water stops shall be made by welding in an approved fashion. Lapping of water stops at joints and the use of adhesives for jointing purposes shall not be permitted unless specifically authorized. Water stops shall not be perforated or damaged. Concrete shall be carefully placed and compacted to ensure dense impervious concrete, particularly around the ribs of water stops. At all joints the concrete shall be placed up to the centerline of the water stop. All starters to walls of watertight construction shall be cast using hung formwork so that the concrete in the starters is placed simultaneously with the concrete in the slab.

C. **Coating:** Coat inside faces of structures containing waters with protective coating as per section 07162.

D. **Testing:** In addition to the testing required in Paragraph 3.19.C, further tests to determine the watertightness of the structure shall be performed in accordance with BS 8007. The structure shall be filled with fresh water to the designed level and after a period to allow for absorption of water, the faces remote from the liquid shall be inspected for leaks over a 7-day period. Any defects shall be repaired by an approved method, which could involve demolition and rebuilding, or lining of the structure.

3.19 QUALITY CONTROL AND TESTING

A. General:

1. Testing Laboratory:

a. Employ an independent testing agency to perform tests and to submit test reports.

b. Be responsible for taking, identifying and delivering to the test laboratory all test samples called for in this Specification. The testing laboratory shall be responsible for the testing. Collect all test results and deliver them to the Engineer in the format and detail as specified.

2. Testing Laboratory Qualifications: The testing laboratory shall be accredited by NAMAS or an equivalent National Standard and shall have a Quality System in accordance with ANSI Q9001.

B. **Quality Control - Testing on Fresh Concrete:** Compressive Strength Test for Structural Concrete:

a. Sampling, curing and testing shall be performed using the relevant procedures in ASTM C 31, ASTM C 39, and ASTM C 172.

1) Samples for production of concrete cylinders shall be taken at the point of placement at the average rate of one per 25 cu. m of concrete placed, with a minimum of one sample taken every day that the mix is used. A sample shall consist of six 150 mm cylinders molded and stored for laboratory-cured test specimens except when field-cured test specimens are required. Three cylinders are for testing at 7 days after casting, three for testing at 28 days after casting.

2) If frequency of testing provides fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

3) When total quantity of a given class of concrete is less than 25 cu. m, the Engineer may waive strength testing if adequate evidence of satisfactory strength is provided.

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

b. Records: Records shall be kept of the mix details and position in the works of all batches of concrete and of all samples taken for cylinders and other specimens and of their test results. A copy shall be supplied to the Engineer within 24 hours after recording/testing. Records shall contain, but not be limited to, the following information:

1) Date, time, location, and volume of pour.

2) Concrete temperature (at time of placement).

3) Cement type and manufacture.

4) Concrete type and class.

5) Aggregate type and source.

6) Admixture details.

7) Water/cement ratio

c. For the 28-day tests, the concrete will be deemed to comply with the specified design strength if the average strength determined from all sets of 3 consecutive tests is at least equal to the specified design strength and no individual strength test falls below the specified design strength by more than 3.5 N/sq. mm. Any concrete not complying with the specified design strength shall be at risk for removal and replacement at the Contractor's expense.

d. The 28-day cylinder crushing results shall be grouped consecutively in groups of 40 and each group shall have a standard deviation less than 3.5 N/sq. mm. If the standard deviation is greater than or equal to 3.5 N/sq. mm, then concrete production shall be investigated by the Engineer and further tests on trial mixes may be

required.

e. Tests shall be carried out at 7 days to establish a relationship between the 7-day and 28-day strengths. This relationship shall be used to interpret future test results in order to predict the corresponding 28-day strength. The Engineer shall be advised without delay of any 7-day test result indicating that the corresponding 28-day strength will likely fail to meet the specified strength so that any necessary action can be taken to minimize the effect of such possible failure.

5. Salt Content: The total concentration of sulfates and chlorides in fresh concrete shall be measured at least once a week for all structural grades of concrete. Tests shall be in accordance with BS 1881. Concentrations of each ion shall not exceed the limits specified in Paragraph 2.12. If these limits are exceeded, the concrete pour from which the samples were taken shall be rejected and further tests performed on the casted concrete in accordance with Paragraph 3.19.C to determine the total extent of the problem.

6. Slump: Slump tests shall be performed in accordance with ASTM C 143. There shall be a minimum of one test at the point of discharge for each day's pour for each type of concrete. Additional tests shall be performed when concrete consistency appears to have changed

C. **Quality Control - Testing on Hardened Concrete:**

1. General: The Engineer may request samples to be taken and tests carried out on any hardened structural grade concrete as specified below if he suspects that the concrete does not meet the specified requirements. If the tests confirm that the concrete does not meet the requirements of this Specification, then the Engineer may require the concrete to be removed at the Contractor's expense. If the tests confirm

that the concrete meets the requirements of this Specification, then the cost of taking the samples shall not be at the Contractor's expense.

2. Compressive Strength Tests: The Engineer may request cores to be drilled from a particular pour. 100 mm diameter cores shall be drilled as requested, in accordance with ASTM C 42, and sent for crushing. If the cores from that pour have an average compressive strength less than 85 percent of the characteristic strength or any individual core has a compressive strength less than 75 percent of the characteristic strength, it shall be evidence that the concrete from which it was taken is not in accordance with the specified requirements.

3. Concrete Cover: The Engineer may check the concrete cover over the reinforcement with a cover meter. Any indication that the cover is generally less than the requirements specified in Paragraph 3.6 shall be checked by limited surface concrete removal. If it is confirmed that the actual cover is generally less than specified, then the concrete shall be removed at the Contractor's expense. In the case of localized lack of cover and where appearance is not important, a repair shall be effected by removal of the inadequate cover and the cutting back of concrete for 50 mm behind the reinforcement. Resurfacing of the concrete with the specified cover shall be carried out as a repair by a specialist subcontractor as specified in Article 3.16.

4. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be used but shall not be used as the sole basis for acceptance or rejection.

5. Additional Tests: The testing agency shall make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as

directed by the Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

------x-x-x------

DIVISION 04 20 00

UNIT MASONRY ASSEMBLIES

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 covers the work of concrete masonry assemblies and includes:

1. Non-fire rated masonry assemblies.
2. Fire rated masonry assemblies.
3. Reinforced masonry assemblies.

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

1. Concrete Masonry Units.
2. Mortar and Grout Materials.
3. Ties and Anchors.
4. Miscellaneous Masonry Accessories.
5. Mortar and Grout Mixes.
6. Joint Reinforcement.

a. Horizontal reinforcement.

b. Vertical reinforcement.

C. Products installed, but not furnished, under this Section include the following:

1. Hollow-metal frames in unit masonry openings, furnished under Division 8, Section "Custom Steel Doors and Frames."
2. Steel Lintels for Unit Masonry Specified in Division 5 “Metal Fabrications”.
3. Manufactured regrets in masonry joints for metal flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."

1.3 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops the net-area compressive strengths (f'm) at 28 days indicated in part 2.

1. For Concrete Unit Masonry: As follows, based on net area:

a. f'm = 10.3 MPa.

1.4 SUBMITTALS

A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.

B. Shop Drawings: Shop drawings including full details of masonry works for different assemblies and covering anchorage to concrete elements cavity walls and flashings, masonry reinforcement, bond pattern, joints, horizontal joint reinforcement, openings, lintels and other details as the Engineer may require.

C. 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.
3. Reinforcing bars and accessories.

D. 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.

E. **Material Test Reports:** From a qualified independent testing agency employed and paid by contractor or manufacturer indicating and interpreting test results relative to compliance of the following proposed masonry materials for compliance with requirements indicated:

1. Each type of masonry unit required.

a. Include size-variation data for brick, 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. Mortar complying with property requirements of ASTM C 270.

3. Grout mixes, Include description of type and proportions of grout ingredients.

F. **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 brick, 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 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 determined according to test methods stated in Clause 1.5/F of this Section.
4. Each material and grade indicated for reinforcing bars.
5. Each type and size of anchor, tie, and metal accessory.
6. Each type and size of joint reinforcement.

1.5 QUALITY ASSURANCE

A. **Contractor** shall perform a survey and inspection of foundations for compliance with dimensional tolerances. Full comprehensive report shall be submitted to the Engineer prior to commencing building masonry assemblies on foundations.

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. **Testing Agency Qualifications**: To qualify for acceptance, an independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of agency- submitted criteria conforming to ASTM C1093, that it has the experience and compatibility to satisfactorily conduct the testing indicated without delaying the work.

D. **Mockups:** Before installing unit masonry, 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. Locate mockups in the locations indicated or, if not indicated, as directed by Engineer.
2. Build mockups of reinforced assembly, double walls, typical cavity wall and single-wythe wall areas as shown on Drawings.
3. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
4. Protect accepted mockups from the elements with weather-resistant membrane.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, unless such deviations are specifically approved by Engineer in writing.
7. Approved mockups will become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units 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. If units become wet, do not install until they are in an air-dried condition.

1. Protect Type I concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.

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. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

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

PART 2 - PRODUCT

2.1 CONCRETE MASONRY UNITS

A. General: Provide shapes indicated and as follows for each form of concrete masonry unit required**.**

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.
3. Provide bullnose units for outside corners, unless otherwise indicated.
4. Types of concrete masonry shall be as follows:

a. Use solid blocks for all below-grade assemblies.

b. Use solid blocks for walls, partitions or wythes to be finished with mechanically attached dimension stone cladding.

c. Use solid blocks or units for 4” thick partitions.

d. Use units open from both sides for reinforced masonry assemblies.

e. Use cellular blocks (open from one side) for other assemblies.

B. **Concrete Masonry Units:** ASTM C 90 and as follows**:**

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength specified in Clause 1.3/A of this Section.
2. Weight Classification: Normal weight.
3. Provide moisture-controlled units. All masonry units shall be factory cured.
4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

a. Where units are to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

5. Cement: ASTMC 150, Type I, Gray color.
6. Aggregates: Do not use aggregates made from pumice, scoria, or tuff.

2.2 MORTAR AND GROUT MATERIALS

A. **Portland Cement:** ASTM C 150, Type I. Provide gray color.

B. **Hydrated Lime:** Do not use Lime.

C. **Pre-Packaged Portland Cement Mix:** Pre-Packaged blend of Portland cement, water, and aggregate complying with requirements specified in this Article combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C 1142. Compressive strength at 28 days shall not be less than 5 MPa (minimum cement sand ratio 1:3-4 by volume).

D. **Aggregate for Mortar:** ASTM C 144.

1. White-Mortar Aggregates: Natural white sand or ground white stone.

E. **Aggregate for Grout:** ASTM C 404.

F. **Water:** Potable.

2.3 REINFORCED STEEL BARS

A. **Deformed High Yield Steel Bars:** BS 4449, Grade 460.

B. **Reinforcing Bar Positioners:** Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 4.8-mm steel wire, hot-dip galvanized after fabrication.

a. Provide units with either two loops or four loops as needed for number of bars indicated or calculated.

2.4 TIES AND ANCHORS, GENERAL

A. **General:** Provide ties and anchors, specified in subsequent articles that comply with requirements for metal and size of this Article, unless otherwise indicated.

B. **Wire:** As follows:

1. Stainless-Steel Wire: ASTM A 580, Type 304.
2. Wire Diameter: 6.4 mm.

C. **Stainless Steel Sheet:** As follows:

1. Stainless-Steel Sheet: ASTM A 167, Type 304.
2. Stainless-Steel Sheet Thickness: 2.8 mm.

D. **Stainless-Steel Plates, Bars, and Dowels:** ASTM A 167, ASTM A 276, or ASTM A 666, Type 304; temper as required to support loads imposed without exceeding allowable design stresses.

2.5 ADJUSTABLE ANCHORS FOR CONNECTING TO STRUCTURAL STEEL FRAME

A. **General:** Provide two-piece assemblies as described below, allowing vertical or horizontal differential movement between wall and frame

parallel to plane of wall but resisting tension and compression forces perpendicular to it.

1. Manufacturer's standard anchors with crimped 6.4 mm diameter wire anchor section for welding to steel and triangular-shaped wire tie section sized to extend within 25 mm of masonry face and as follows:
2. Welding to Steel Structural Framing: Comply with requirements specified in Division 5, Section "Structural Steel".
3. Touch-Up Painting: Paint welds with two coats of zinc rich paint to ASTM A 780.

B. **Wire Diameter:** 6.4 mm.

2.6 ANCHORS FOR CONNECTING TO CONCRETE

A. **General:** Provide two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section: Dovetail anchor section formed from 1.6-mm thick, stainless- steel sheet.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 25 mm of masonry face, made from 6.4-mm diameter.

2.7 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.
2. All cement used shall be ordinary Portland (ASTM C 150, Type I).

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. Standard: ASTM C270, lime-free Portland cement based.
2. Wet Mix Life: Less than 1.5 hours.
3. Initial Adhesion at 28 days: Not less than 0.3 N/mm2.
4. Bending Strength: Around 1 N/ mm2.
5. Compressive Strength: Not less than 5 ±1 N/ mm2.
6. Minimum Cement Sand Mix: 1:3
7. Testing: ASTM C 780.

b- **Mixed Mortar:** Comply with ASTM C 270 as follows:

1. Bending Strength: Around 1 N/ mm2.
2. Compressive Strength: Not less than 5 ±1 N/ mm2.
3. Minimum Cement Sand Mix: 1:3.
4. Testing: ASTM C 780.
5. Limit Cementitious materials in mortar to Portland cement and lime.
6. Do not add lime to the mix. Approved liquid admixtures that substitute the performance of lime may be added to the mix.

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 ASTM C 476 for

dimensions of grout spaces and pour height.

2. Provide grout with a slump of 200 to 275 mm as measured according to ASTM C 143.
3. Use fine grout (maximum size of coarse aggregate is 10 mm) in grout spaces less than 100 mm in least horizontal dimension, unless otherwise indicated.
4. Use coarse grout in grout spaces 100 mm or more in least horizontal dimension, unless otherwise indicated.
5. The Contractor shall submit laboratory design mix of concrete grout to obtain performance specified in of this Sub-Clause. Minimum cement content shall be 300 kg/m^3.
6. Compressive Strength: Minimum 17.5 MPa at 28 days.
7. Grout shall be mixed in proportions according to approved design mix to obtain compressive strength specified using the minimum quantity of water to ensure the necessary fluidity and to render it capable of penetrating the work.
8. Concrete grout shall be used or filling hollow cells in bond beams, under concrete lintels and bond beams, in window and door jambs and other locations for reinforced masonry assemblies as specified. 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.

2.10 JOINT REINFORCEMENT

A. **General:** Provide joint reinforcement formed from the following:

1. Stainless-steel wire, ASTM A 580, Type 304.

B. **Description:** Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 3 m, with prefabricated corner and tee units, and complying with requirements indicated below:

1. Wire Diameter for Side Rods: 4.8 mm.
2. Wire Diameter for Cross Rods: 4.8 mm.

C. For single-wythe masonry, provide type as follows with single pair of side rods:

1. Truss design with continuous diagonal cross rods spaced not more than 407 mm o.c.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions, with installer present for compliance with requirements for installation tolerances and other conditions affecting performance of unit masonry. Do not proceed with installation until unsatisfactory conditions have been corrected.

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. **Thickness:** Build cavity and 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.

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

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

D. 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, where possible. 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.

E. 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.

F. **Wetting of Brick:** Wet brick before laying. Allow units to absorb water so they are damp but not wet at the time of laying.

3.3 CONSTRUCTION TOLERANCES

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

1. Variation from Plumb: For vertical lines and surfaces of columns, walls, and arrises, do not exceed 3 mm in 3 m, nor 5 mm in 6 m, nor 6 mm in 12 m or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 3 mm in 6 m, nor

in 12 m or more. For vertical alignment of head joints, do not exceed plus or minus 3 mm in 3 m, nor 6 mm maximum.

2. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 3 mm in 6 m, nor 6 mm in 12 m or more. For top surface of bearing walls, do not exceed 2 mm in 3 m, nor 1.0 mm within width of a single unit.

3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls, and partitions, do not exceed 6 mm in 6 m, nor 10 mm in 12 m or more.

4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 5 mm nor plus 10 mm.

5. Variation in Mortar-Joint Thickness: Do not vary from bed-joint thickness indicated by more than plus or minus 3 mm, with a maximum thickness limited to 12 mm. Do not vary bed-joint thickness from bed-joint thickness of adjacent course by more than 3 mm. Do not vary from head-joint thickness indicated by more than plus or minus 3 mm. Do not vary head-joint thickness from adjacent head-joint thickness by more than 3 mm. Do not vary from collar-joint thickness indicated by more than minus 3 mm or plus 10 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 following bond pattern; do not use units with less than nominal 100-mm horizontal face dimensions at corners or jambs.

1. One-half running bond with vertical joint in each course centered on units in courses above and below.

C. **Connection Between Walls And Partitions:** walls and partitions should generally be bonded, tied or dowelled to one another at angles and junctions. Where it is necessary for a partition to be connected to an adjacent wall, this should be done by toothing or block bonding unless otherwise specified

D. 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.

E. **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.

F. **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.

G. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.

1. At exterior frames, insert extruded polystyrene board insulation

around perimeter of frame in thickness indicated, but not less than 19 mm to act as a thermal break between frame and masonry.

H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

I. Fill cores in hollow concrete masonry units with grout 600 mm under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

J. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. 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.

3. 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”.

K. Lay walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow 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.
4. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 10-mm joints.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

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 continuous masonry joint reinforcement as indicated below.

Install entire length of longitudinal side rods in mortar with a minimum cover of 16 mm on exterior side of walls, 13 mm elsewhere. Lap reinforcement a minimum of 150 mm.

1. Space reinforcement not more than 406 mm o.c.
2. Space reinforcement not more than 203 mm o.c. in foundation walls and parapet walls.
3. Provide reinforcement in mortar joint 1 block course above and below wall openings and extending 305 mm beyond openings.

a. Reinforcement above is in addition to continuous reinforcement.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL JOINTS

A. **General:** Install control joints in unit masonry at maximum intervals of 6.00 meters length and 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. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake joint.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete.

3.8 FIRE RATED MASONRY ASSEMBLIES

A. **Fire Rating:** 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 REINFORCED UNIT MASONRY INSTALLATION

A. **Temporary Formwork and Shores:** Construct formwork and shores to support reinforced masonry elements during construction.

1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout.

Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. **Placing Reinforcement:** Comply with requirements of requirements of Division 3, Section “Cast-In-place concrete”.

C. **Grouting:** Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

1. Comply with requirements of ACI 530.1 or Section 2104.6 in the Uniform Building Code (UBC) for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.10 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 15 mm in width between masonry and structural member, unless otherwise specified. Keep open space free of mortar or other rigid materials.

2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 620 mm o.c. vertically and 920 mm o.c. horizontally.

4. Fill space with compressible joint filler and seal edges flush with joint sealant, unless otherwise indicated. Comply with Division 7, Section "Joint Sealants".

3.11 ANCHORING MASONRY TO CONCRETE COLUMNS AND WALLS

A. Anchor masonry to concrete where masonry abuts or faces concrete columns or walls, comply with the following:

1. Anchor masonry to concrete with metal anchors embedded as specified in masonry joints and attached to concrete.

2. Space anchors as indicated, but not more than 420 mm o.c. vertically and 915 mm o.c. horizontally.

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.

3.14 LINTELS

A. Concrete Lintels:

1. Precast lintels: Comply with requirements of Division 3, Section “Plant Precast Structural Concrete”.

2. Cast-In-Place Concrete lintels: Comply with requirements of Division 3, Section “Cast-In-Situ Concrete”. C. Provide steel lintels where openings up to 610 mm wide are indicated.

D. Provide reinforced concrete lintels where shown and where openings of more than 610 mm are shown without structural steel or other

supporting lintels.

E. Provide minimum bearing of 200 mm at each jamb, unless otherwise indicated.

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DIVISION 05 52 13

PIPE AND TUBE RAILING

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 PERFORMANCE REQUIREMENTS

A. **General:** In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of handrail and railing 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 and Railings:** Provide handrails and railings complying with requirements of ASTM E 985 for structural performance, based on testing performed according to ASTM E 894 and ASTM E 935.

C. **Thermal Movements:** Provide exterior handrails and railings 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 and railings.

2. Grout, anchoring cement, and paint products.

B. **Shop Drawings:** Show fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.

1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 STORAGE

A. Store handrails and railings in a dry, well-ventilated, weather tight place, and protect from damage.

PART 2 – PRODUCTS

2.1 METALS

A. **General:** Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.

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:

a. Black finish, for welded assemblies

b. Galvanized finish for mechanical assemblies.

c. Type F, or Type S, Grade A, Schedule 80, unless higher 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.

C. **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 non-galvanized 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.

2.2 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 and Railings to Other Construction:** Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction

indicated and capable of withstanding design loads.

1. For steel handrails, railings, and fittings, use plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

C. **Fasteners for Interconnecting Handrail and Railing 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 and railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for handrails and railings indicated.

2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. **Cast-in-Place, chemical and Post-installed 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 acceptable to the Engineer.

1. Cast-in-place anchors.
2. Chemical anchors.
3. Expansion anchors.

2.3 GROUT AND ANCHORING CEMENT

A. **Non-shrink, Nonmetallic Grout:** Premixed, factory-packaged, non staining, noncorrosive, nongaseous grout complying with ASTM C

1107. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

2.4 FABRICATION

A. **General:** Fabricate handrails and railings 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 and railings 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.

2.5 STEEL FINISHES

A. General: Unless otherwise indicated on Drawings, pipe and tube railings specified under this Section shall be galvanized and factory painted.

B. **Galvanizing After Fabrication:** 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.

C. 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.

D. Preparation for Shop Priming: After galvanizing, thoroughly clean handrails and railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic- phosphate process.

E. Apply shop primer to prepared surfaces of railings, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.
2. Stripe paint corners, crevices, bolts, welds, and sharp edges.

3.3 RAILING CONNECTIONS

A. **Non-welded Connections:** Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of handrails and railings.

B. **Welded Connections:** Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. **Expansion Joints:** Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 50mm beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 150 mm of post.

3.4 ANCHORING POSTS

A. Unless otherwise indicated on drawings, use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with the following material, mixed and placed to comply with anchoring material manufacturer's written instructions:

1. Non-shrink, nonmetallic grout.

B. Cover anchorage joint with flange of same metal as post, attached to post as follows:

1. By set screws.

C. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 3 mm build-up, sloped away from post.

D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

A. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ANCHORING RAILING ENDS

A. Anchor railing ends into concrete and masonry with round flanges connected to railing ends and anchored into wall construction with post installed anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces

1. Connect flanges to railing ends using non-welded connections.

3.6 ATTACHING HANDRAILS TO WALLS

A. Attach handrails to wall with wall brackets. Provide brackets with 38-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. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
4. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

3.7 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.

3.8 PROTECTION

A. Protect finishes of handrails and railings 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

that 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.

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DIVISION 08 14 00

WOODEN DOORS

PART 1 - GENERAL SECTION

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 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. 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 doors to be factory finished and finish requirements.

C. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:

1. Faces of factory-finished doors with opaque finish. Show the full range of colors available.

D. Samples for Verification: As follows:

1. Corner sections of doors approximately 200 by 250 mm with door faces an 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.

2. Louver blade and frame sections, 150 mm long, for each material and finish specified.

1. Frames for light openings, 150 mm long, for each material, type, and finish required.

1.4 QUALITY ASSURANCE

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

B. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

1.5 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 plastic bags or cardboard cartons.

2. 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.

1.6 WARRANTY

A. Door Manufacturer's Warranty: Provide written Warranty, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 6.5 mm in a 1100-by-2100-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 Substantial Completion:

a. Semi-solid-core Interior Doors: Two years.

PART 2 - PRODUCTS

2.1 WOODS, GENERAL

A. Woods shall be marked-on as Class-1 stocks which shall be properly treated, adequately seasoned and free from roy or insect attack, splits, shakes or checks, warping, twisting, chipping, loose knots and waming. Provide woods of wane-free edges. Woods shall conform to the requirements of BS EN No. 942; plywood to BS EN No. 636.

B. **Preservative Treatment:** All woods and plywood used shall be preservative treated. Application is to be carried out after cutting and machining, but before assembly, by a processor licensed by the treatment solution manufacturer. Solution strengths and treatment by pressure, vacuum or immersion process are to be selected to achieve service life and to suit wood treatability. Moisture content of wood at time of treatment is to be as specified for use in the work. After treatment, allow wood to dry before use. For each batch of wood, provide certificate of assurance that treatment has been carried out as specified.

C. Softwoods

1. Douglas Fir: Yellowish Brown wood of average intensity not less than 570 kg/m3 at 12% moisture content.

2. Whitewood: White/pale Yellowish Brown wood of average intensity of 470 kg/m3.

3. Or as directed by the Architect.

D. Hardwoods

1. White Oak Wood: Yellowish Brown, fine-grained wood of strong, compact, homogenous fibers and uniform texture. Average intensity shall not be less than 720 kg/m3 at 12% moisture content. Or as directed by the Architect.

E. Plywood

1. General: Shall be highest grade to BS EN 636, designated as veneer, with minimal imperfections as peeled. Moisture content shall not exceed 12%. Thickness shall be as specified. Employ plywood glued with INT glues to BS 1203.

2. Softwood Plywood: All layers shall be of softwood.

3. Hardwood Plywood: White Oak plywood; White-Oak veneer 0.90 mm thick minimum shall be factory hot-applied at exposed face of door, cut and match of veneer shall be selected by the Consultant.

2.2 ACCESSORY MATERIALS

A. Preservative treatment: Type listed in BS 1282 (except coal tar creosote) obtained from approved manufacturer to provide protection against termites and other destroying organisms.

B. Adhesives: Close contact type to BS EN 301 or BS EN 302, suitable for the purpose and compatible with preservative treatment.

2.3 NON-FIRE RATED SEMI-SOLID-CORE FLUSH WOOD DOORS

A. **General:** Non-fire-rated flush wood doors shall be swinging-type side-hinged to jambs of frames with hand of doors as indicated on Drawings, fabricated to the general tolerances of BS No. 4787 and shall consist of a frame (door leaf frame) consisting of stiles and rails constructed of Douglas fir and a core constructed of a lower-density softwood (Whitewood). Core strips shall cover, at least, 67% of door leaf area (Semi-solid core).

B. **Door Leaf Frame:** Stiles and rails shall be of dimensions as indicated on Drawings but in no case shall the width be less than 140 mm for mortise stile or less than 100 mm for other stile and rails, before lipping. Door-leaf-frame components shall be continuously lipped at outer edges with 20 mm thick lipping constructed of White Oak wood. Oak 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.

C. **Semi-Solid Cores:** Shall be horizontal rails of White wood, of uniform width. Ratio of solid to vacant shall be 2:1. Horizontal core rails shall be in one pieces. Throughout door leaf height, at least, two horizontal core rails shall be mortise-and- tenon jointed and glued to stiles.

D. **Facing:** Facing material shall be 6 mm thick plywood glued with waterproof glue under pressure to both sides of core. 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. Type of facing material shall be as follows:

1. Doors of Opaque Finish: Softwood plywood

E. **Thickness of Doors:** Unless otherwise indicated on Drawings, finish thickness of flush non-fire-rated wood doors shall be 45 mm; thickness of stiles, rails and core strips shall be 33 mm and 45 mm wood lipping.

2.4 LOUVERS AND LIGHT FRAMES

A. Metal Louvers: As follows:

1. Blade Type: Vision proof, inverted V.

2. Metal and Finish: Extruded aluminum with clear anodic finish, 25micron thick minimum.

2.5 HARDWARE

A. Hardware shall be as indicated in Hardware Sets and Door Schedule and as specified in Division 8, Section "Door Hardware".

2.6 FABRICATION, GENERALLY

A. Flush wood doors shall be fabricated in accordance with details shown on Drawings, requirements of this Section, general tolerances of BS No. 4787 and other in-contradicting requirements of BS No. 1186: Part 2.

B. Carefully plan and layout the work to erect wood doors and to accommodate the work of other trades.

C. Finish wood shall be smoothly dressed and sanded prior to assembly of door inner frames and shall be free from open joints, hammer and machine marks and other defects or surface blemishes.

D. Re-treat all treated wood which is sawn along the length, ploughed, thickness, planed or otherwise extensively processed. Treat wood surfaces exposed by minor cutting and drilling with two flood coats of

solution recommended for the purpose by the treatment solution manufacturer.

E. Finish and cut wood at exact dimensions as required. Stile and rails shall be connected only in glued mortise-and tenon joints with horizontal core strips assembled and jointed at their locations between rails, along stiles. The resulting frame shall be robust, firm and square.

F. Facing material shall be glued to core and frame. No nail-fixing exposed or concealed, for facing material shall be permissible. The assembly shall be glued under pressure with waterproof casein glue and be thoroughly dried and seasoned.

G. Join lipping at outer perimeter of frame in continuous tongue-and-groove joints with glue.

H. Factory machine doors for hardware that is not surface applied. Locate hardware as indicated on approved shop drawings. Comply with final hardware schedules, door frame shop drawings, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

I. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Light Openings: Trim openings with moldings of material and profile indicated.

2. Louvers: Factory install louvers in prepared openings.

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DIVISION 08 51 13

ALUMINUM WINDOW

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 DEFINITIONS

A. Structural test pressure, for uniform load structural test, is equivalent to 150 percent of design pressure.

1.3 PERFORMANCE REQUIREMENTS

A. **General:** Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified and that are of test size indicated below:

1. Size indicated on Drawings.

B. **Structural Performance:** Provide aluminum windows capable of withstanding the following, including wind loads based on passing AAMA/NWWDA 101/I.S.2, Uniform Load Structural Test, at basic wind speed indicated:

1. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length 19 mm, whichever is less, at design pressure based on structural computations.

2. Basic Wind Speed: As indicated in meters per second at 10 m above grade.

   Determine wind loads and 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 C, Basic Wind Speed 130 km/hr.

C. **Air Infiltration:** Maximum rate not more than indicated when tested according to AAMA/NWWDA 101/I.S.2, Air Infiltration Test.

1. Maximum Rate: 2 cu. m/h x sq. m of area at an inward test pressure of 300 Pa.

D. **Water Resistance:** No water leakage as defined in AAMA/NWWDA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/NWWDA 101/I.S.2, Water Resistance Test.

1. Test Pressure: 20 percent of positive design pressure, but not more than 580Pa.

E. **Thermal Transmittance:** Provide aluminum windows with a whole-window U-value maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 and ASTM E 1423.

1. U-Value: shall not exceed U-value specified for glass insulating units specified in Division 8, Section "Glazing".

F. **Sound Transmission Class:** Provide glazed windows rated for not less than 26 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

G. **Thermal Movements:** Provide aluminum windows, including anchorage, that accommodate thermal movements of units resulting from the following maximum change (range) in ambient and surface temperatures without buckling, distortion, opening of joints,

failure of joint sealants, damaging loads and stresses on glazing and connections, and other detrimental effects. Base Consulting calculation on actual surface temperatures of materials due to solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 35 deg C, ambient; 65 deg C material surfaces.

H. **Life-Cycle Testing:** Test according to AAMA 910 and comply with AAMA/ WDMA 101/I.S.2.

1.5 SUBMITTALS

A. **Product Data:** Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

B. **Shop Drawings:** Include plans, elevations, sections, details, hardware, attachments to other Work, operational clearances, and the following:

1. Joinery details.
2. Flashing and drainage details.
3. Weather-stripping details.
4. Glazing details.
5. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional Consultant responsible for their preparation and used to determine the following:

a. Structural test pressures and design pressures from basic wind speeds indicated.

b. Deflection limitations of glass framing systems.

C. **Samples for Initial Selection:** For units with factory-applied color finishes.

D. **Samples for Verification:** For aluminum window components required, prepared on Samples of size indicated below.

1. Main Framing Member: 300-mm- long, full-size sections of extrusions with factory-applied color finish.
2. Hardware: Full-size units with factory-applied finish.
3. Weather Stripping: 300-mm- long sections.
4. Consultant reserves the right to require additional samples that show fabrication techniques, workmanship, and design of hardware and accessories.

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

1. 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. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

G. **Product Test Reports:** Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each type, grade, and size of aluminum window. Test results based on use of down-sized test units will not be accepted.

H. **Maintenance Data:** For operable window sash, operating hardware, weather stripping and finishes to include in maintenance manuals.

1.6 QUALITY ASSURANCE

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

B. **Manufacturer Qualifications:** A firm experienced in manufacturing items specified in this section similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to manufacture required units.

C. **Installer Qualifications:** An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1. 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 Consultants and Employers, and other information specified

D. **Testing Agency Qualifications:** An independent testing agency, acceptable to Consultant, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

E. **Source Limitations:** Obtain aluminum windows through one source from a single manufacturer.

F. **Fenestration Standard:** Comply with AAMA/W DMA 101/I.S.2, "Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors," for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

G. **Mockups:** Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.

1. Build mockup in building envelope wall in locations selected by Consultant.
2. Build one mockup of each type of windows indicated on Drawings.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion as judged solely by the Consultant, otherwise dismantle mockups, remove site and install permanent works.

H. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. **Field Measurements:** Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. **Special Warranty:** Provide written warranty signed by Manufacturer and Contractor in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Failure to meet performance requirements.
2. Structural failures including excessive deflection.

3. Water leakage, air infiltration, or condensation.
4. Faulty operation of movable sash and hardware.
5. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
6. Insulting glass failure.

B. Warranty Period: 5 years from date of Substantial Completion.

C. Warranty Period for Metal Finishes: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

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 2.00 mm thickness at any location for the main frame and sash members.

B. **Fasteners:** Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be non-corrosive 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, non-corrosive, 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.

C. **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.

D. **Reinforcing Members:** Aluminum or nonmagnetic stainless steel, complying with ASTM B 456 for Type SC 3 severe service conditions, provide sufficient strength to withstand design pressure indicated.

E. **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. Sliding Weather Stripping: Wool, polypropylene, or nylon woven pile with nylon--fabric or aluminum-strip backing complying with AAMA 701/702 requirements.

F. **Compression-Type Weather Stripping:** Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when aluminum window is closed.

1. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864 fabricated from EPDM.

G. **Replaceable Weather Seals:** Comply with AAMA 70 1/702.

H. **Sealant:** For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

2.2 GLAZING

A. **Glass and Glazing Materials:** Refer to Division 8 Section "Glazing" for glass units and glazing requirements applicable to glazed aluminum window units.

B. **Glazing System:** Manufacturer's standard factory-glazing system that produces weather tight seal or as indicated in Division 8 Section "Glazing".

2.3 HARDWARE

A. **General:** Provide manufacturer's standard hardware fabricated from aluminum, designed to smoothly operate, tightly close, and securely lock aluminum windows and sized to accommodate sash or ventilator weight and dimensions. Cadmium- plated hardware is not permitted. Do not use aluminum in frictional contact with other metals. Where exposed, provide extruded, cast, or wrought aluminum with clear anodized satin finish.

B. **Hardware, General:** Comply with AAMA 902.

C. **Sill Cap/Track:** Extruded aluminum with finish matching that of window track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior

D. **Locks and Latches:** Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.

E. **Roller Assemblies:** Low-friction design.

F. **Four- or Six-Bar Friction Hinges:** Comply with AAMA 904.

1. Locking mechanism and handles for manual operation.

2. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, non-staining, non-corrosive, durable material.

G. **Limit Devices:** Provide limit devices designed to restrict sash or ventilator opening.

1. Safety Devices: Limit clear opening to 150 mm for ventilation; with custodial key release.

H. **Horizontal-Sliding 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.

I. Projected Windows: Provide the following operating hardware:

1. Hinge: Five-knuckle butt hinge.

2. Lock: Combination lever handle and cam-action lock with concealed pawl and keeper.

3. Limit Device: Concealed friction adjustor, adjustable stay bar limit device; located on jamb of each ventilator.

2.4 FABRICATION

A. **General:** Fabricate aluminum windows, in sizes indicated, that comply with AAMA/WDMA 101/I.S.2 for performance class and performance grade indicated. Include a complete system for assembling components and anchoring windows.

B. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.

C. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials 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 for hardware bridging thermal breaks at frame or vent sash.

D. **Weather Stripping:** Provide full-perimeter weather stripping for each operable sash and ventilator.

3.2 INSTALLATION

A. **General:** Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components; Drawings; and Shop Drawings.

B. Install 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 windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in "Dissimilar Materials" Paragraph in Appendix B in AAMA/WDMA 101/I.S.2.

3.3 ADJUSTING

A. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weather- tight closure. Lubricate hardware and moving parts.

3.4 PROTECTION AND CLEANING

A. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor 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 window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

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DIVISION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

B. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1. Cylinders for locks on aluminum and glass entrance doors.

1.2 SUBMITTALS

A. **Product Data:** Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. **Samples:** For exposed door hardware of each type indicated below, in specified finish, full size. Tag with full description for coordination with the Door Hardware Schedule. Submit samples before, or concurrent with, submission of the final Door Hardware Schedule.

1. Door Hardware: Each piece of hardware indicated in hardware schedule or on Drawings.

2. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

C. **Product Certificates:** Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.

1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.

D. **Maintenance Data:** For each type of door hardware to include in

maintenance manuals specified in Division 1.

E. **Warranties:** Special warranties specified in this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

2.1 SCHEDULED DOOR HARDWARE

A. **General:** Provide door hardware for each door to comply with requirements in this Section, and the Door and Hardware sets Schedule annexed at the end of Part 3.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.

2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. **Designations:** Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door and Hardware sets Schedule at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. International hardware manufactures have to establish their compliance with these specifications and with international fire codes for fire rated hardware.

2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

2.2 HINGES AND PIVOTS

A. **Standards:** Comply with the following:

1. Butts and Hinges: BHMA A156.1.
2. Template Hinge Dimensions: BHMA A156.7.
3. Self-Closing Hinges and Pivots: BHMA A156.17.
4. Pivots: BHMA A156.4.

B. **Size:** Provide the following minimum sizes, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Max: Door Size (mm)	Hinge height (mm)	Standard Weight	Heavy Weight
800 by 2125 by 35	80	3.1	--
900 by 2125 by 35	100	3.3	--
900 by 2285 by 38	113	3.4	4.6
1050 by 2285 by 38	113	3.4	4.6
1200 by 3050 by 38	125	3.7	4.8

C. **Template Requirements:** Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

D. **Hinge Weight:** Unless otherwise indicated, provide the following:

1. Entrance Doors: Heavy-weight hinges.
2. Doors with Closers: Antifriction-bearing hinges.
3. Interior Doors: Standard-weight hinges.

E. **Hinge Base Metal:** Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel alloy 316, with stainless-steel pin
2. Interior Hinges: Stainless steel alloy 304, with stainless-steel pin.
3. Hinges for Fire-Rated Assemblies: Stainless steel alloy 304, with stainless- steel pin.

F. **Hinge Options:** Comply with the following where indicated in the Door Hardware Schedule or on Drawings:

1. Maximum Security Pin: Fix pin in hinge barrel after it is inserted.

2. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:

a. Out-swinging exterior doors.

3. Corners: 4-mm radius.

G. **Hinges, General:** Shall be full mortise, template, of concealed ball bearing, 5 knuckles, suitable for high frequency applications and of life time warranty.

2.3 LOCKS AND LATCHES

A. **Standards:** Comply with the following: Mortise Locks and Latches: BHMA A156.13.

1. Interconnected Locks and Latches: BHMA A156.12.

2. Auxiliary Locks: BHMA A156.5.

3. Push-Button Combination Locks: BHMA A156.2.

4. Electromagnetic Locks: BH MA A156.23.

5. Delayed-Egress Locks: BH MA A156.24.

6. Exit Locks: BHMA A156.5.

B. **Mortise Locks:** Stamped steel case with stainless steel parts; BHMA Grade 1; Series 1000. Provide mortise locks for exterior doors, throughout the job, except for toilets. All lock shall be ADA compliant Marine grade mortise locks shall be provided in the exterior and in non-air-conditioned areas. Provide ten years product warranty for performance and finish.

C. **Mortise Lock:** Shall be types produced for extra-heavy-duty applications. Lock lever shall be of anti-vandalism design.

D. Where threaded bars are used to assemble the two pieces of lock spindle, minimum inner diameter of threading bar shall be 6 mm.

E. **Interconnected Locks:** BHMA Grade 1; Series 5000.

F. **Auxiliary Locks:** BHMA Grade 1.

G. **Push-Button Combination Locks:** BHMA Grade 1 for cylindrical locks and Grade 2 for mortise locks.

H. **Certified Products:** Provide door hardware listed in the following BHMA directories:

1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."

I. **Lock Trim:** Comply with the following: All trims to have returns. Trims shall be ADA compliant. Trim shall be stainless steel BHMA-630

1. Lever: Wrought, forged, or cast.
2. Escutcheon (Rose): Wrought, forged, or cast.
3. Dummy Trim: Match lock trim and escutcheons.
4. Lockset Designs: Provide the lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:

J. **Lock Functions:** Function numbers and descriptions indicated in the Door Hardware Schedule comply with the following:

1. Mortise Locks: BHMA A156.13.
2. Interconnected Locks: BHMA A156.12.

K. **Lock Features:** Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Mortise Locks: Minimum 19-mm latch bolt throw.
2. Deadbolts: Minimum 25-mm bolt throw.
3. Pairs of Doors: 16-mm minimum throw of latch.
4. Fire-Rated Doors: Comply with UL requirements for throw of bolts and latches on rated fire openings.
5. Heavy duty anti friction tongue.
6. Non handed auxiliary guard latch.
7. Adjustable stainless steel armor front.
8. Seven pin interchangeable core cylinder.
9. Corrosion protected steel case.

L. **Rabbeted Doors:** Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.

M. **Backset:** 70 mm, unless otherwise indicated.

N. **Lock Function:** Provide lock functions as described below, but not limited to

1. F-04 Office lock, with faceplate button depressed function.
2. Classroom function for stores
3. F-13 Corridor lock.
4. Provide classroom dead bolts for main doors of toilets and janitors rooms Additional lock function will be required as per function of various rooms.

O. Locks shall have double buttons in face plate. For Office Locks the handle will rotate only when bottom button is depressed or turning key for outside cylinder. For other locks, the bottom button in face plate shall also retract the latch.

P. These requirements for mortise locks shall remain applicable in all respects for wood doors, steel doors and minimum doors.

2.4 DOOR BOLTS

A. **Standards:** Comply with the following:

1. Surface Bolts: BHMA A156.16.

2. Manual Flush Bolts: BHMA A156.16.

B. Surface Bolts: BHMA Grade 1.

1. Flush Bolt Heads: Minimum of 13-mm- diameter rods of brass, bronze, or stainless steel with minimum 300-mm- long rod for doors up to 2100 mm in height. Provide longer rods as necessary for doors exceeding 2100 mm.

C. Flush Bolts: BHMA Grade 1, designed for mortising into door edge.

D. **Bolt Throw:** Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Half-Round Surface Bolts: Minimum 22-mm throw.

2. Interlocking Surface Bolts: Minimum 24-mm throw.

3. Fire-Rated Surface Bolts: Minimum 25-mm throw; listed and labeled for fire- rated doors.

4. Dutch-Door Bolts: Minimum 19-mm throw.

5. Mortise Flush Bolts: Minimum 19-mm throw.

2.5 EXIT DEVICES

A. **Standard**: BHMA A156.3.

1. BHMA Grade: Grade 1.

B. **Certified Products:** Provide exit devices listed in BHMA's "Directory of Certified Exit Devices."

C. **Panic Exit Devices:** Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

D. **Panic Exit Devices:** For non-fire rated doors are to be as specified in Sub-Clause but with facility to hold latchbolts in retracted position so

that the doors may be used as push/pull. Dogging is to be accomplished by a hex key cylinder installed on the body of touch bar devices or a hexagonal key in the hinge and lock cases of cross bar devices

E. **Fire Exit Devices:** Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

F. **Dummy Push Bar:** Nonfunctioning push bar matching functional push bar.

1. Operation: Rigid.

G. **Outside Trim:** Lever with cylinder or Pull with cylinder; unless otherwise indicated material and finish to match locksets, unless otherwise indicated.

1. Match design for locksets and latchsets, unless otherwise indicated.

H. **Through Bolts:** For exit devices and trim on metal doors and non-fire-rated wood doors.

I. Fire and panic exit devices shall be of concealed latches. No exposed latches shall be accepted.

2.6 CYLINDERS AND KEYING

A. **Standards:** Comply with the following:

1. Cylinders: BHMA A156.5.

2. Key Control System: BHMA A156.5.

B. Cylinder Grade: BHMA Grade 1 or Grade 1A.

C. **Cylinders:** Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Seven.

2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.

3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.

D. **Permanent Cores:** Manufacturer's standard; finish face to match lockset; complying with the following:

1. Interchangeable Cores: Core insert, removable by use of a special key, and usable with other manufacturers' cylinders.

2. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

E. Construction Keying: Comply with the following:

1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

2. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 4 constructions master keys for Employer/Consultant use.

a. Replace construction cores with permanent cores, as directed by Employer.

b. Furnish permanent cores to Employer for installation.

F. **Keying System:** Unless otherwise indicated, provide a factory-registered keying system complying with the following requirements:

1. Master Key System: Cylinders are operated by a change key and a master key.

G. **Keys:** Provide stainless steel keys complying with the following:

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: Information to be furnished by Employer.

2. Quantity: In addition to one extra blank key for each lock, provide the following:

a. Cylinder Change Keys: Three.

b. Master Keys: Five.

H. **Key Control System:** BHMA Grade 1 system, including key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers. Contain system in metal cabinet with baked- enamel finish.

1. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key- holding panels and pin-tumbler cylinder door lock.

2. Capacity: Able to hold keys for 150 percent of the number of locks.

3. Cross-Index System: Set up by key control manufacturer, complying with the following:

a. Card Index: Furnish four sets of index cards for recording key information. Include three receipt forms for each key-holding hook.

2.7 STRIKES

A. **Standards:** Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.

2. Strikes for Interconnected Locks and Latches: BHMA A156.12.

3. Strikes for Auxiliary Deadlocks: BHMA A156.5.

4. Dustproof Strikes: BHMA A156.16.

B. **Strikes:** Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latch bolts, as recommended by manufacturer.

2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

4. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.

5. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non recessed strike for bolt.

C. **Dustproof Strikes**: BHMA Grade 1.

2.8 CARD READER

A. Proximity Reader with Keypad:

1. Technology: Wiengand proximity system compatible with building security system.

2. Housing: Weather resistant ABS plastic housing. Color as selected by Consultant from manufacturer's full line.

3. Keypad: 12 button key pad for entry of Personal Identification Number (PIN) in addition to proximity card.

4. Display Status: 3 LED status display and controllable beeper to indicate reader operation and status.

5. Tamper Detection: Mechanical tamper switch to send signal to security room if reader is completely removed from wall in addition to detecting when reader has been separated from its back plate.

6. Provide all mounting plates, cables, programs and other items required to make card reader work with building security system.

2.11 CLOSERS

A. Closers, General-unless otherwise indicated, provide closers on all fire-rated doors, exterior doors, toilet and locker room doors, sound-retardant doors, corridor doors, doors between heated/cooled and unheated / uncooled areas, elevator equipment room doors, and other door as required. Closer shall be tested for 10 million cycles and will

withstand 57-degree ambient temperature and will be provided with all-weather hydraulic fluid. Closer will be equipped with the function of variable back check and delayed action. Closer will be provided with ten years warranty and warranty against leaks. Closer will be non-banded. Closer will be provided with adjustable with speed and hold open facility. Concealed door closer will be completely and components will minimize tempering and vandalism.

1. Size of Units: Unless otherwise indicated, comply with the manufacturer's recommendation for size of door control unit depending on size of door, exposure to weather and drafts, and anticipated frequency of use.
2. Arms: Provide parallel arms for all overhead closers, unless otherwise indicated. Provide closer unit one size larger than recommended for use with standard arms.
3. Closing Cycle: Comply with requirements of authorities having jurisdiction or the Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)", whichever are most stringent

a. Opening Force: Comply with the following maximum opening-force requirements for locations indicated:

1) Exterior Doors: 67 N.
2) Interior Doors: 22.2N.

4. Construction: Provide marine-grade construction for closers in non-air-conditioned areas and indoor swimming pool areas, consisting of nonferrous and stainless steel components.

B. **Aluminum Entrance Doors:** Provide concealed door closer. Standards: Comply with the following:

1. Closers: BHMA A156.4.

C. Surface Closers: BHMA Grade 1.

D. **Concealed Closers:** BHMA Grade 1.

E. **Certified Products:** Provide door closers listed in BHMA's "Directory of Certified Door Closers".

F. **Door Closers on Fire Rated Doors:** Shall be type that closes the door and positively latch the door.

G. **Hold-Open Closers/Detectors:** Coordinate and interface integral smoke detector and closer device with fire alarm system. Fire rated doors with closers of hold open facility shall release automatically in case of fire based on signal from the fire alarm system (electric release door closer). System of release device for double leaf fire rated doors shall be adjustable so as the inactive leaf shall close prior to the active leaf and that active leave shall positively latch to the inactive leaf at final closing position (electric release door closers and door coordinator).

H. **Flush Floor Plates:** Provide finish cover plates for floor closers unless thresholds are indicated. Match door hardware finish, unless otherwise indicated.

I. **Recessed Floor Plates:** Provide recessed floor plates with insert of floor finish material for floor closers, unless thresholds are indicated. Provide extended closer spindle to accommodate thickness of floor finish.

J. Weather Comply with manufacturer's written recommendation of exposure to weather. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

H. **Grade:** Door closers shall be from types tested for 10 million cycles of operation and sized for door leafs of minimum weight of 200

kilogram per leaf for both steel doors and external doors.

2.12 PROTECTIVE TRIM UNIT

A. **Standard:** Comply with BHMA A156.6.

B. **Materials:** Fabricate protection plates from the following to match requirement indicate:

1. Stainless Steel: beveled top and 2 sides.

C. Protection Plates, General:

1. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.

D. **Kick Plates:** beveled top and two side edges (B3E). Provide two kick plates for toilet doors. Kick plate will ensure that the door bottom is protected.

a. Metal Plates: Stainless steel, 3.00 mm thick

E. **Armor Plates:** 3 mm thick, 914 mm high by full width of door less clearance for stops on door frame.

F. **Fasteners:** Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.

G. Furnish protection plates sized 38 mm less than door width on push side and 13 mm less than door width on pull side, by height specified in Door Hardware Schedule.

2.13 STOPS AND HOLDERS

A. **Standards:** Comply with the following:

1. Stops and Bumpers: BHMA A156.16.
2. Mechanical Door Holders: BHMA A156.16.
3. Electromagnetic Door Holders: BHMA A156.15.
4. Combination Overhead Holders and Stops: BHMA A156.8.
5. Door Silencers: BHMA A156.16.

B. **Stops and Bumpers:** BHMA Grade 1.

C. **Mechanical Door Holders:** BHMA Grade 1.

D. **Combination Floor and Wall Stops and Holders:** BHMA Grade 1.

E. **Combination Overhead Stops and Holders:** BHMA Grade 1.

F. **Electromagnetic Door Holders for Labeled Fire Door Assemblies:** Coordinate with fire detectors and interface with fire alarm system.

G. **Floor Stops:** For doors, unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.

1. Where floor or wall stops are not appropriate, provide overhead holders.

H. **Silencers for Wood Door Frames:** BHMA Grade 1; neoprene or rubber, minimum 16 by 19 mm; fabricated for drilled-in application to frame.

I. **Silencers for Metal Door Frames:** BHMA Grade 1; neoprene or rubber, minimum diameter 13 mm; fabricated for drilled-in application to frame.

2.14 DOOR GASKETING

A. **Standard:** Comply with BHMA A156.22.

B. **General:** Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications a n d elsewhere as indicated.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. **Air Leakage:** Not to exceed 0.000774 cu. m/s per m of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.

D. **Smoke-Labeled Gasketing:** Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.

1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke- labeled doors.

E. **Fire-Labeled Gasketing:** 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 UL 10B or NFPA 252.

F. **Sound-Rated Gasketing:** Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

G. **Replaceable Seal Strips:** Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

H. **Gasketing Materials:** Comply with ASTM D 2000 and AAMA 70 1/702.

I. **Weather-stripping and Seal Types:** Unless otherwise indicated, provide the following, or approved equal:

1. Door Shoes: Extruded aluminum, with vinyl seal and integral rain drip.
2. Rain Drips: Extruded aluminum. Unless noted otherwise, provide rain drips for all exterior doors.
3. Automatic Door Bottoms: Extruded aluminum with neoprene insert for doors to achieve STC of 47 or better, as indicated in the hardware schedule.

4. Meeting Stile Seals (Astragal Seals): Extruded anodized aluminum, with silicon seal.

5. Weather-stripping, Smoke Seals, and Sound Retarding Gaskets: Compression-type self-adhesive silicone gasket applied to door stops, white color.

6. Security Astragals: Cam operated, automatic security astragal.

2.15 THRESHOLDS

A. **General:** Unless otherwise indicated, provide standard metal threshold units of type, size, and profile as shown or scheduled. Comply with ANSI/BHMA A156.21.

1. Material: Extruded aluminum, non-slip finish, except as otherwise specified.

2. Exterior Hinged Doors: Provide units not less than 100 mm wide, and not more than 12-mm-high, with beveled edges providing a floor level change with a slope of not more than 1:2, formed to accommodate change in floor elevation where indicated, fabricated to accommodate door hardware and to fit door frames, and as follows:

a. For in-swinging doors provide units with interlocking lip and interior drain channel; include hook on bottom edge of door and drain pan.

b. For out-swinging doors provide rabbeted type units with replaceable weather-strip insert in stop. Provide threshold with thermal break when mentioned in the hardware schedule

B. **Exterior Thresholds:** ANSI/BHMA A156.21, extruded aluminum. Provide flat saddle type or interlocking type with resilient insert as shown.

C. **Threshold for Aluminum Entrance Doors:** Manufacturer's standard threshold with cutouts coordinated for operating hardware, with anchors and jamb clips, and not more than 12-mm-high, with beveled edges providing a floor level change with a slope of not more than 1:2, formed

to accommodate change in floor elevation where indicated.

D. **Threshold for Doors with Exit Devices:** Extruded aluminum latching type, with replaceable vinyl inserts.

E. Interior Thresholds: Extruded aluminum flat saddle type with smooth surface.

2.16 MISCELLANEOUS DOOR HARDWARE

A. **Standard:** Comply with the following:

1. Auxiliary Hardware: BHMA A156.16.

2. Exit Alarms: BHMA A156.5.

B. **Auxiliary Hardware:** BHMA Grade 1, unless otherwise indicated.

C. **Boxed Power Supplies:** Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labeled for use with fire alarm systems.

2.17 FABRICATION

A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Consultant.

1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. **Base Metals:** Produce door hardware units of base metal specified, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. **Fasteners:** Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet

metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Steel Machine or Wood Screws: For the following fire-rated applications:

a. Mortise hinges to doors.
b. Strike plates to frames.
c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:

a. Surface hinges to doors.
b. Closers to doors and frames.
c. Surface-mounted exit devices.

4. Spacers: For through bolting of hollow metal doors.
5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.18 BASE METAL

A. Base Metal for hardware and door furniture shall be as follows:

1- Exterior Units: Stainless Steel alloy 316
2- Interior Units: Stainless Steel alloy 304

2.19 FINISHES

A. **Standard:** Comply with BHMA A156.18.

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.

D. **BHMA Designations:** Comply with base material and finish requirements indicated by the following:

1. BHMA 630: Satin stainless steel, over stainless-steel base metal.

3.3 INSTALLATION

A. **Mounting Heights:** Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. **Key Control System:** Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

3.4 ADJUSTING

A. **Initial Adjustment:** Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 75 mm from the latch, measured to the leading edge of the door.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

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DIVISION 08 80 00

GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes glazing for the following products, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Aluminum entrances.
2. Sliding automatic entrances doors.
3. Aluminum windows
4. Structure-Sealant-Glazed curtain walls.
5. Glass visions in doors.

1.3 DEFINITIONS

A. **Manufacturer:** Manufacturer is used in this Section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

B. **Deterioration of Laminated Glass:** Defects developed from normal use that are attributed to the manufacturing process and not to glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's directions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated glass standard.

C. **Deterioration of Insulating Glass:** Failure of the hermetic seal under normal use due to causes other than glass breakage and improper practices for maintaining, and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of glass. Improper practices for maintaining and cleaning glass do not comply with the manufacturer's directions

1.4 PERFORMANCE REQUIREMENTS

A. **General:** Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (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; and other defects in construction.

B. **Glass Design:** Glass thicknesses indicated on Drawings shall be considered as the minimum only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass liters for the various size openings in the thicknesses and strengths (annealed or heat-treated) to meet or exceed the following criteria:

1. Minimum glass thickness, nominally, of liters shall be 6.0 mm.
2. Tinted and heat-absorbing glass thicknesses for each tint indicated shall be the same throughout Project.
3. Minimum glass thicknesses of liters, whether composed of annealed or heat- treated glass, shall be selected so the worst-case probability of failure does not exceed the following:

a. Eight liters per 1000 for liters set vertically or not over 15 degrees off vertical and under wind action. Determine minimum thickness of monolithic annealed glass according to ASTM E 1300. For other than monolithic annealed glass, determine thickness per glass manufacturer's standard method of analysis including applying adjustment factors to ASTM E 1300 based on type of glass.

b. One lite per 1000 for liters set over 15 degrees off vertical and under action of wind and rain.

C. **Thermal Movement:** Allow for normal thermal movement resulting from the following maximum change (range) in ambient and surface temperatures acting on glass-framing members and glazing components. Base Consulting calculation on materials' actual surface temperatures 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. **Deflection:** Center deflection of loaded glass liters shall not exceed L/10t where L is the short span of the lite in mm and t is the thickness of the monolithic or laminated lite in mm.

E. **Loads on Glass:**

1. Glass shall be of appropriate thickness to withstand the greater of the following pressures, or combinations thereof, acting normal to the surface without center point deflections in excess of those specified. Load combinations shall be per the specific requirements of the 1997 Uniform Building Code:

a. Wind Load: Positive and negative wind load shall be based on the UBC for a basic wind speed of 80 mph (130 km/h), Importance Factor 1.15, and Exposure Category "C".

b. Human Impact Loads: Comply with CPSC 16 CFR 1201 Category II in those locations designated as hazardous locations by UBC Section 2406.4.

2. Calculate glass thickness based upon the following minimum safety factors.

a. Vertical Glazing:

1) Fully Tempered Glass (Type FT): 1.4.

1.5 SUBMITTALS

A. **Product Data:** For each glass product and glazing material indicated.

B. **Samples:** Samples for verification purposes of 300-mm-square samples of each type of glass indicated except for clear monolithic glass products, and 300-mm-long samples of each color required for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative in color of the adjoining framing system.

C. **Test Reports:**

1. Compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.

2. Compatibility test report from manufacturer of insulating glass

edge sealant indicating that glass edge sealants were tested for compatibility with other glazing materials including sealants, glazing tape, gaskets, setting blocks, and edge blocks.

3. Product test reports for each type of glazing sealant and gasket indicated, evidencing compliance with requirements specified.

D. **Certificates:** Product certificates signed by glazing materials manufacturers certifying that their products comply with specified requirements.

1. Separate certifications are not required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program of a recognized certification agency or independent testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. **Glazing Publications:** Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. AAMA TIR-A7 “Sloped Glazing Guidelines" and "Glass Design for Sloped Glazing".
2. FGMA "Glazing Manual".
3. LSGA "Design Guide".
4. SIGMA TM-3000 "Vertical Glazing Guidelines" and TB-3001 "Sloped Glazing Guidelines".

B. **Safety Glass:** Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.

C. **Insulating Glass Certification Program:** Provide insulating glass units permanently marked either on spacers or at least one component lite of units with appropriate certification label of Insulating Glass Certification Council (IGCC).

D. **Glazier Qualifications:** Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.

E. **Single-Source Responsibility for Glass:** Obtain glass from one source for each product indicated below:

1. Primary glass of each (ASTM C 1036) type and class indicated.
2. Heat-treated glass of each (ASTM C 1048) condition indicated.
3. Laminated glass of each (ASTM C 1172) kind indicated.
4. Insulating glass of each construction indicated.

F. **Single-Source Responsibility for Glazing Accessories:** Obtain glazing accessories from one source for each product and installation method indicated.

G. **Preconstruction Compatibility and Adhesion Testing:** Submit to sealant manufacturers samples of each glass, gasket, glazing accessory, and glass-framing member that will contact or affect glazing sealants for compatibility and adhesion testing as indicated below:

1. Use test methods standard with sealant manufacturer to determine if priming and other specific preparation techniques are required for rapid, optimum glazing sealants adhesion to glass and glazing channel substrates.

a. Perform tests under normal environmental conditions during installation. b. Submit not less than 4 pieces of each type and finish of glass-framing members and each type, class, kind, condition, and form of glass (monolithic, laminated, insulating units) for adhesion testing, as well as one sample of each glazing accessory (gaskets, setting, blocks and spacers) for compatibility testing.

c. Schedule sufficient time to test and analyze results to prevent delay in the progress of the Work.

d. Investigate materials failing compatibility or adhesion tests and obtain sealant manufacturer's written recommendations for corrective measures, including using special primers.

2. Testing is not required when glazing sealant manufacturer can submit required preparation data that is acceptable to Consultant and is based on previous testing of current sealant products for adhesion to and compatibility with submitted glazing materials.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glass and glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, and other causes.

1. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator's recommendations for venting and sealing to avoid hermetic seal ruptures.

1.9 WARRANTY

A. **General:** 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 will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1. Warranty Period: Manufacturer's standard, but not less than 10 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRIMARY FLOAT GLASS PRODUCTS

A. **Float Glass:** ASTM C 1036, Type I (transparent glass, flat), Class as indicated below, and Quality q3 (glazing select).

1. Class 1 (clear), for interior glass unless otherwise indicated.

2. Class 2 (tinted, heat-absorbing, and light-reducing), Arctic-Blue B. **Translucent Glass:** Glass that transmits light with varying degrees of diffusion produced by sandblasting of surface of clear float as specified in Sub-Clause A of this Clause so that vision is not clear and light transmittance is lower than clear Glass. Requirements of translucent glass are to be similar to that of ASTM 1036-85, Type 2, Class 1.

2.2 HEAT-TREATED FLOAT GLASS

A. **Fabrication Process:** By horizontal (roller-hearth) process.

B. **Clear, Heat-Treated Float Glass:** ASTM C 1048, Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), kind as indicated below.

1. Kind FT (fully tempered).
2. Fully Tempered: Kind FT (fully tempered, having a minimum surface compression of 110,000 kPa (16,000 psi.).
3. "Roller distortion" and/or "ripples" shall run in the same direction for the entire Project. Glass shall be heat-treated through the use of a horizontal tempering furnace.

C. **Tinted, Heat-Treated Float Glass:** ASTM C 1048, Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 2 (tinted heat-absorbing and light-reducing), Quality q3 (glazing select), with tint color and performance characteristics for 6.0- mm-thick glass matching those indicated for annealed primary tinted float glass; kind as indicated below:

1. Kind FT (fully tempered) as indicated on Drawings and for the following applications:

a. Exterior liters of exterior double insulating glass units.

b. For low glazing (800mm and below) applications including liters of double insulating glass units.

2.1 COATED FLOAT GLASS

A. **General:** Provide coated glass complying with requirements indicated in this Article.

B. Provide Kind FT (fully tempered) where safety glass is indicated.

C. **Low-e Coated Float Glass:** Float glass with solar-reflective metallic-oxide coating applied on surface #2 or surface #3 of the double insulating unit.

Low-e coating shall be neutral color.

2.3 LAMINATED GLASS

A. **Laminated Glass:** Comply with ASTM C 1172, Kind LT (two liters of fully tempered Type 1 glass) and other requirements specified. Refer to primary and heat-treated glass requirements relating to properties of glass products comprising laminated glass products. Unless otherwise indicated, provide the following types of glass:

1. Laminated Glass 8.76 mm Thick Tinted/Clear:

a. Outer Lite: Fully tempered, minimum 4.0 mm thick. Provide Arctic-Blue color tinted as selected by consultant from manufacturer's standard colors to match existing.

b. 2x0.38 mm PVB interlayer

c. Inner Lite: Clear, fully tempered, minimum 4.0 mm thick.

2. Laminated Glass 13.50 mm Thick Clear/Clear:

a. Outer Lite: Fully tempered, minimum 6.0 mm thick

b. 4x0.38 mm PVB interlayer

c. Inner Lite: Clear, fully tempered, minimum 6.0 mm thick

3. Laminated Glass 6.67 mm Thick Clear/Clear:

a. Outer Lite: Fully tempered, clear glass minimum 3.0 mm thick.

b. 2x0.38 mm PVB interlayer

c. Inner Lite: Clear, fully tempered, minimum 3.0 mm thick.

B. **Interlayer:** Interlayer material as indicated below, and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

1. Interlayer Material: Polyvinyl Butyral (PVB) sheets, clear, minimum thickness as indicated before.

C. **Laminating Process:** Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:

1. Laminate liters with polyvinyl butyral interlayer in autoclave with heat plus pressure.

3.3 GLAZING, GENERAL

A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions where indicated on Drawings provide minimum necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by referenced standards and Project conditions during installation.

C. Protect glass from edge damage during handling and installation as follows:

1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass liters with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.

2. Remove damaged glass from Project site and legally dispose of offsite. Damaged glass is glass with surface or edge damage or other

imperfections that, when installed, 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 elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, 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 liters.

G. Provide spacers for glass sizes larger than 1270 united mm (length plus height) as follows:

1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with specified performance requirements.

2. Provide 3-mm minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.

I. Set glass liters 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 manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

L. Any glass lites installed within 900 mm from adjoining finish floor level (sill glazing) shall be marked as safety in compliance with standard referenced in this Section.

3.4 TAPE GLAZING

A. Position tapes on f ixed 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 in one continuous length. Do not stretch tapes to make them fit opening.

C. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. W here framing joints are horizontal, cover these 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 eac lite is installed.

F. Where required, 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. Where required, 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 stretch allowance during installation.

B. Secure compression gaskets in place with joints located at corners to compress gaskets producing a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

C. Install gaskets so they protrude from face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers between glass liters and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers 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. Install pressurized gaskets to protrude slightly out of

channel to eliminate dirt and moisture pockets.

3.7 GLASS PARTITIONS

A. Fix partitions firm in place indicated on Drawings at lines indicated, perfectly plumb without deviations from horizontal or vertical lines. Provide firm connections between glass liters of partitions and glass fins. All bolts and anchors shall be tightly screwed without overstressing glass. Use concealed EPDM washers and shims as required and comply with manufacturer's instructions.

3.8 PROTECTION AND CLEANING

A. Protect exterior glass from breakage 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 them 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 build-up of dirt, scum, alkali deposits, or stains, and remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents and vandalism, during construction period.

E. Wash glass on both faces in each area of Project not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass using materials and methods recommended by glass manufacturer.

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DIVISION 09 24 00

CEMENT PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Portland cement plaster.
2. Metal Lath suspended ceiling.

1.3 SUBMITTALS

A. **Product Data:** For each product specified.

B. **Samples for Initial Selection:** manufacturer's color charts consisting of actual units or sections of units at least 300 mm square showing the full range of colors, textures, and patterns available for each type of finish indicated.

1. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.
2. Include similar Samples of material for joints and accessories involving color selection.

C. **Shop Drawings:** Submit shop drawings for suspended metal lath ceilings including layout and details of ceilings installation

D. **Material Certificates:** certificate signed by manufacturer for each kind of plaster aggregate certifying that materials comply with requirements.

1.4 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a

minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **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 Consultant.
2. Erect mockups 1200 by 1200 mm by full thickness in presence of Consultant using materials, including lath, support system, and control joints, indicated for final Work.
3. Notify Consultant 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 Consultant'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.
7. When directed demolish mockups, remove rubbles from site and replace with permanent works.

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 indoor, 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.

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 suitable coverings, 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. **Interior Plaster Work:** Maintain at least 10 deg C temperature in areas to be plastered for at least 48 hours before, during, and after application.

E. **Ventilation:** Provide natural or mechanical means of ventilation to properly dry interior spaces after Portland cement plaster has cured.

F. 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 METAL SUPPORTS FOR SUSPENDED CEILINGS

A. **General:** Size metal ceiling supports to comply with ASTM C 1063, unless otherwise indicated.

B. **Post installed 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. Chemical anchor.

C. **Wire for Hangers and Ties:** ASTM A 641 M, Class 1 zinc coating, soft temper.

D. **Rod Hangers:** Mild steel, zinc coated.

E. **Flat Hangers:** Mild steel, zinc coated or protected with rust-inhibitive paint.

F. **Channels:** Cold-rolled steel, minimum 1.5-mm- thick base (uncoated) metal and 11.1-mm- wide flanges, and as follows:

1. Carrying Channels: Based on design calculations but not less than 38 mm deep, 0.7 kg/m.

G. **Finish:** ASTM A 653M, Z180 hot-dip galvanized coating for framing where indicated.

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.

b. Form: Coil.

c. Special Pieces: For internal corners.

2. Diamond-Mesh Lath for Plaster Background: Comply with the following requirements:

a. Configuration: Flat.

i. Weight: 1.1 kg/sq. m.

3. Rib Lath for Suspended Ceilings: Comply with the following requirements:

a. Configuration: Flat, rib depth of not over 3 mm.

Weight: 1.8 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.

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 on exterior exposures while allowing full plaster encasement.

C. **Cornerbeads:** Small nose cornerbeads fabricated from the following metal, with expanded flanges of large-mesh diamond-metal lath allowing full plaster encasement.

D. **Casing Beads:** Square-edged style, with expanded flanges.

E. **Curved Casing Beads:** Square-edged style, fabricated from aluminum coated with clear plastic, preformed into curve of radius indicated.

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. **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.

H. **Lath Attachment Devices:** Material and type required by ASTM C 1063 for installations indicated.

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

C. **Cement Color:** Gray.

D. **Lime:** do not use lime.

E. **Plasticiser:** ASTM C260.

F. **Sand Aggregate for Base Coats:** ASTM C 897.

G. **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. **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.

1)

D. **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. Do not use lime in plaster mixes.

B. **Base-Coat Mixes and Compositions:** Proportion materials for respective base coats in parts by volume per sum of cementitious materials for aggregates to comply with the following requirements for each method of application and plaster base indicated. Adjust mix proportions below within limits specified to attain workability.

C. **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.

D. **Three-Coat Work over Metal Lath:** Base-coat proportions as indicated below:

1. Scratch Coat: 1 part Portland cement, 2-1/2 to 4 parts aggregate.
2. Brown Coat: 1 part Portland cement, 3 to 5 parts aggregate.
3. Admixtures and workability aids, as per manufacturer’s printed instructions

E. **Two-Coat Work over Concrete and Concrete Unit Masonry:** Base-coat proportions as indicated below:

1. Base Coat: 1 part Portland cement, 5 parts aggregate, aerating plasticiser as per manufacturer’s recommendation.

F. **Job-Mixed Finish Coats:** Proportion materials for finish coats in parts by volume for cementitious materials and parts by volume per sum of cementitious materials to comply with the following requirements:

1. Proportions using sand aggregates as indicated below:

a. 1 part Portland cement, 4 parts aggregate, aerating plasticiser as per manufacturer's recommendation.

2.7 MIXING

A. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION OF CEILING SUSPENSION SYSTEMS

A. **Preparation and Coordination:** Coordinate installation of ceiling suspension system with installation of overhead structural systems to ensure inserts and other structural anchorage provisions have been installed to receive ceiling hangers in a manner that will develop their full strength and at spacings required to support ceiling.

B. **Hanger Installation:** Attach hangers to structure above ceiling to comply with ML/SFA 920, "Guide Specifications for Metal Lathing and Furring," and with referenced standards.

C. Install ceiling suspension system components of sizes and spacings indicated, but not in smaller sizes or greater spacings than those required by referenced lathing and furring installation standards.

1. Wire Hangers: Space 4-mm- diameter wire hangers not over 1200 mm o.c, parallel with and not over 900 mm perpendicular to direction of carrying channels, unless otherwise indicated, and within 150 mm of carrying channel ends.

2. Carrying Channels: Space carrying channels not over 900 mm o.c. with 1200- mm o.c. hanger spacing.

3. Furring Channels to Receive Metal Lath: Space furring channels not over

500 mm o.c. for 1.8-kg/sq. m flat rib lath.

3.2 PREPARATIONS FOR PLASTERING

A. Clean plaster bases and substrates for direct application of plaster, removing loose material and substances that may impair the Work.

B. 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).

C. **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 with corrosion resistant fasteners at not more than 600mm centers along both edges.

D. Apply dash coat on concrete and concrete masonry surfaces indicated for direct plaster application. Moist-cure dash coat for at least 24 hours after application and before plastering.

E. Install temporary grounds and screeds to ensure accurate rodding of plaster to true surfaces; coordinate with scratch-coat work.

F. Refer to Division 6 Sections for installing permanent wood grounds, if any.

G. **Surface Conditioning:** Immediately before plastering, dampen concrete and concrete unit masonry surfaces that are indicated for direct plaster application. Determine and apply amount of moisture and degree of saturation that will result in optimum suction for plastering.

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 referenced ML/SFA specifications and 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 150 mm wide strip of building paper overlaid with 300 mm 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 Consultant:

a. Where an expansion or contraction joint occurs in surface of construction directly behind plaster membrane.

b. Distance between Control Joints: Not to exceed 5.5 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 150 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 corner beads on interior work, square and true with plaster faces on exterior work.

I. **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 samples approved by the Consultant.

J. **Number of Coats and Thickness:** Excluding dash coats and dubbing out coats apply plaster of composition indicated, to comply with the following requirements:

1. Two Coats: Base and finish 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. Three Coats: Scratch, base and finish coats over metal lath backgrounds and installations.

3. Overall thickness is to be 15.00 mm for internal plaster and 20.00 mm for external plaster.

4. One plaster base coat (15 mm thick) for walls to be finished with ceramic tiles set with thin bed adhesive.

5. One coat work (15 mm thick) for plaster on concrete structural slabs uniformly floated to a true even plane

6. 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."

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 doorframes, 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 Consultant, that ensure plaster work is without damage or deterioration at the time of Substantial Completion.

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DIVISION 09 75 00

STONE SOLING

1. SCOPE

The work under this section of specifications consists of furnishing all plant, labor, equipment, appliances, materials and performance of all operations required in connection with the construction of stone soling in strict accordance with the specifications and Drawings and/or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. STONE

Stone to be used shall comprise of strong, hard, durable stone of the approved size, free from impurities, quarry sap, dust, dirt and solubility characteristics. The stone shall be obtained from approved quarries and shall be sound, free from laminations and weak cleavages.

3. CONSTRUCTION

3.1 Preparation of Sub-grade

Sub-grade shall be formed of suitable materials free of clods, sod, roots, stumps, brush or other objectionable material.

Sub-grade material shall be placed in successive layers not exceeding 6 inch in thickness and each layer shall be thoroughly compacted at optimum moisture content.

The maximum dry weight density of the sub-grade shall not be less than 95% of Modified AASHTO requirements.

3.2 Stone Ballast Soling

The Stone Ballast shall be well graded and broken hard of 3" mesh obtained from an approved quarry.

The stone shall be laid and packed to even grades and well rolled using vibratory roller/plate compactor to a consolidated thickness of not less than 6

inch or as shown on the Drawings.

The whole of the surface of the compacted stone ballast soling will be blinded with morum or any other approved gritty material done dust (Khaka). After the interstices have been filled with smaller size crushed stone, so as to effectively fill in the voids and crevices, soling area may be watered, if necessary and again thoroughly rolled with the same roller to produce a smooth and even surface free from irregularities, true to line and level.

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DIVISION 09 67 16

MARBLE

1. GENERAL

The work under this section of specifications consists of providing all material, labor, plant, equipment, appliances in any floor and at any height and performing all operations required for providing and installing marble natural stone slab for toilet counters, where shown on the drawings, complete in strict accordance with this section of the specification and the applicable Drawings.

2. SUBMITTALS

The Contractor shall submit manufacturer's specifications and other product data for each type of marble stone and fixtures required, including instructions for handling, storage, installation and protection.

Shop Drawings shall be submitted showing sires, dimensions, sections and profiles of slab, arrangement and provisions for jointing, anchoring, fastening and supports and other necessary fixing details. Indicate locations, layouts and pattern arrangements for each stone type and color, Submit three ranges samples 12" x 12" In size of each type of stone showing color, grade, finishing and texture for approval of the Engineer

3. MATERIAL

3.1 GENERAL

Marble shall be compact, dense, meiam or poros rock of lime stone origin obtained from quarries within Pakistan. It shall have a specific gravity of 27 and hardness number on Moh's scale shall range from 3 to 4.

Obtain each marble stone type from a single quarry and ensure consistent color range and texture throughout the work. All pieces shall be of uniform thickness and truly square in shape.

Provide marble slabs/sills and tiles of specified sizes in floors, stair tread & rise •$ and counter tops as shown on drawings.

Provide marble slabs/sills and tiles of type, colour and finish for each area as directed *by* the Engineer.

Provide stone of specified thickness. Saw cut the back surfaces that are meant to be concealed in finished work.

Provide irregular shaped unite, staircase unite and skirting base units to the profiles of required shapes S sizes and polished exposed surfaces wherever specified.

3.2 MARBLE STONE TYPE

All marble stone types are to be selected and approved by the Engineer for quality* colour and texture.

3.3 BEDS AND BACKINGS

Where applicable, standard cementious screed and mortar beds and backings, mixed and proportioned by volume shall be as follows. -

Grey ordinary Portland Cement: 1 part Sand 2 parts

Water, Clean, fresh and free from deleterious substances

3.4 ADHESIVES, GROUTS AND SEALANTS

Proprietary adhesives, joint grouts and sealants of approved type as required and recommended by the manufacturer for specific application shelf be used. The colour of the joint grout and the sealants shall match with the colour of stone

4. DELIVERY, STORAGE AND HANDLING

Materials shall *be* protected from damage during loading, shipment, delivery and storage. Non- staining materials for blocking and packing shall be used Stack marble at site in accordance with manufacturer recommendations and as

required to prevent staining, scratching, etching or breakage.

5. EXECUTION

5.1 FLOORING, SKIRTING/DADO AND STAIR

Apply cement slurry coat over surfaces of concrete substrate immediately prior to placing setting bed Limit area of application to avoid premature drying out. Install setting bed of required thickness and set stone units before initial set occurs. Apply a thin layer of cement paste to bottom of each unit. Set tamp and level units immediately set units in required pattern with uniform joint widths.

Point joints as soon as possible after initial set. force grout into joints, strike flush and tool slightly concave.

Remove mortar and grout from surfaces while stiff moist and as the work progresses.

Do not permit traffic on finished surface during setting and for a minimum of 24 hours after final pointing of joints.

5.2 REPAIR AND CLEANING

Remove and replace stone units, which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units, which do not match adjoining stonework or are not in line and level as shown on Drawings. Provide new matching units, install and point joints to eliminate evidence of replacement Re-point defective and unsatisfactory joints to provide neat, uniform appearance.

Clean stonework not less than 6 days after completion of work, using clean water and bristle brushes. Do not use wire brushes, acid or caustic type cleaning agents or other

cleaning compounds which may be detrimental to the stone finish or joint grout.

5.3 PROTECTION

Provide covers, boards, supports and all other necessary materials to protect finished work from collapse, deterioration, discoloration or damage during installation and until contract completion,

5.4 POLISHING

The finished surface shall be chemically polished, acceptable to the Engineer.

6. RELATED WORKS INCLUDED IN THE RELEVANT ITEMS OF BOQ.

The under mentioned works are related to the relevant BOQ items. The cost thereof shall *be* deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

- Class 'C' cement concrete screed base and cement sand mortar piaster base under marble floor and skirting/dado etc
- Finishing/grinding, washing & polishing works and all related items and marble tiles.
- 1:2 and 1.4 cement sand roughcast plaster.
- Pointing in marble tiles. cleaning compounds which may be detrimental to the stone finish or joint grout.

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Provide covers, boards, supports and all other necessary materials to protect finished work from collapse, deterioration, discoloration or damage during installation and until contract completion,

5.4 POLISHING

The finished surface shall be chemically polished, acceptable to the Engineer.

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- Finishing/grinding, washing & polishing works and all related items and marble tiles.
- 1:2 and 1.4 cement sand roughcast plaster.
- Pointing in marble tiles.

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DIVISION 09 65 19

PORCELAIN TILES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 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).

C. **Facial Dimension:** Nominal tile size as defined in ANSI A137.1.

1.3 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.

B. **Load-Bearing** Performance: 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:

1. Heavy: Passes cycles 1 through 12. Use where indicated in Finishing Schedules.
2. Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

1.4 SUBMITTALS

A. **Product Data:** For each type of tile, mortar, grout, and other products specified.

B. **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.
3. Locate precisely each joint and crack in tile substrates, record measurements on shop drawings, and coordinate them with tile joint locations, as approved by Consultant.

C. **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.

D. **Grout Samples for Initial Selection:** Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.

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 400 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 Consultant.
2. Full-size units of each type of trim and accessory for each color required.
3. Stone thresholds in 150-mm lengths.

F. **Master Grade Certificates:** For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

G. **Product Certificates:** Signed by manufacturers certifying that the products furnished comply with requirements.

H. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.

I. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product 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 Consultants and Employers, and other any information required by Consultant.

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.

1.6 QUALITY ASSURANCE

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

B. **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.

C. **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.

D. **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.

E. **Source Limitations for Other Products:** Obtain each of the following products specified in this Section from one source and by a single manufacturer for each product:

1. Stone thresholds.
2. Cementitious backer units.
3. Joint sealants.
4. Waterproofing.

F. **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 Consultant.
2. Notify Consultant 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 Consultant'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 as judged solely by the

Consultant at the time of Substantial Completion may become part of the completed Work, otherwise demolish mockups, remove rubbles from site and install permanent works.

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.

1.9 EXTRA MATERIALS

A. Deliver extra materials to Employer. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS,

A. GENERAL

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
2. Retain below with appropriate definitions in referenced part 1 article.
3. NA
4. 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 Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.

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:** W here factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.

F. **Factory-Applied Temporary Protective Coating:** Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating them with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

A. **General Characteristics:** Tiles are to comply with the following general requirements:

1. Floor Tiles:

a. Abrasive Hardness: Minimum Index 253 to ASTM C 501 (unglazed tiles), unless otherwise specified.

b. Bending Strength: Minimum 35 Kg/cm^2 to ASTM C 648

c. Water Absorption: As specified.

d. Chemical Resistance: Unaffected with moderate acids.

e. Tile Rating: For heavy duty floor by a rating system acceptable to the Consultant.

2. Wall Tiles:

a. Water Absorption: Maximum 6% to ASTM C 373.

B. **Unglazed Paver Tile:** Provide flat tile complying With the following requirements:

1. Composition: Porcelain mix.

2. Construction: Color-through.

3. Water Absorption: Less than 0.5% to ASTM C 373.

4. Surface Finish: Matt or Polished as indicated on Drawings.

5. Facial Dimensions: As indicated on Drawings.

6. Thickness: minimum 9.0 mm for tiles and 8.50 mm for fittings.

7. Face: Plain with Square or cushion edges.

C. **Wall Tile:** Provide flat tile complying with the following requirements:

1. Module Size: As indicated on Drawings.

2. Water Absorption: Less than 6% to ASTM C373.

3. Thickness: minimum 8.0 mm.

4. Face: Plain with modified square edges or cushion edges.

C. **Trim Units:** Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:

1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.

2. Shapes: As follows, selected from manufacturer's standard shapes:

a. Base for Portland Cement Mortar Installations: Coved.

b. Wainscot Cap for Thin-Set Mortar Installations: Surface bull nose.

c. External Corners for Thin-Set Mortar Installations: Surface bull nose.

d. Internal Corners: Field-butted square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

D. **Thickness of Tiles:** Specified thickness of tiles excludes thickness of keying patterns on back.

Background/Base: 15mm thick 1:4 cement/sand render on concrete or concrete block works Bedding: Thin cement-based adhesive to be approved.

Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Color to architects approval.

Movement joints: All internal corners; Width: 6mrn

Accessories: all exposed edges and corners to have performed rounded edges

2.3 PORCELAIN WALL TILING

Background/Base: 15mrn thick 1:4 cement/sand render on concrete or concrete blockworks.

Bedding: Thin bed cement-based adhesive. Adhesive: to be approved

Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval.

Joint width: 3mm. Movement joints: Location: All internal corners;

Width: 6mm

Accessories: all exposed edges and corners to have preformed rounded edges In toilets, no tiles behind low level ducts or full height ducts. Complete tiling should be done behind mirrors. In pantry, tiles are to be fixed behind base and wall units but not behind service duct panels.

Plaster only where no tiles.

2.4 FLOOR TILING

Background/Base: screed 1 in-situ concrete

Screed: 11.5:3 cement/sand/aggregate semi-dry screed laid to falls and towards floor drain outlets, overall thickness of flooring to be 75mm

Bedding: Waterproof adhesive on cement 1 sand bed Adhesive: to be approved

Waterproofing: 2 coats Fosroc Nitoproof 10, or equal, to B.S. Standard. laid to manufacturer's recommendations, with necessary accessories

Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval

Joint width: 2.5mm.

Movement joints: location: At all perimeters including door thresholds; Width: 6mm- Accessories:

Skirting: Coved skirting tiles, 100mm high to match ceramic floor tiles, set flush with render, to be fixed on plastered walls, grouted with epoxy grout Nitotile 489 as supplied by Fosroc or equal approved, applied in accordance with manufacturer's recommendations.

2.5 NA

2.6 GROUTING MATERIALS

A. **Sand-Portland Cement Grout:** ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.

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 Consultant from manufacturer's full range of standard and custom colors. Finish shall be smooth, unless otherwise specified or directed by the Consultant.

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.

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. **Temporary Protective Coating:** Provide product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; is compatible with tile, mortar, and grout products; and is easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 49 to 60 deg C per ASTM D 87.

C. **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 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.

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DIVISION 09 66 00

TERRAZZO TILE FLOORING / CAST IN SITU TERRZZO

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Terrazzo Tiles Flooring.
2. Cast in Situ Terrazzo.

1.3 DEFINITIONS

A. **Module Size:** Actual tile size (12" x 12" x 1"thick).

B. **Facial Dimension:** Actual tile size (minor facial dimension as measured per ASTM C 499).

C. **Facial Dimension:** Nominal tile size as defined in ANSI A137.1.

1.4 PERFORMANCE REQUIREMENTS

A. **Static Coefficient of Friction:** For tile installed on Flooring surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1 Level Surfaces: Minimum 0.6.

B. **Load-Bearing Performance:** 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:

1. Heavy: Passes cycles 1 through 12. Use where indicated in Finishing Schedules.
2. Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

1.5 SUBMITTALS

A. **Product Data:** For each type of tile, mortar, grout, and other products specified.

B. **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.

3. Locate precisely each joint and crack in tile substrates, record measurements on shop drawings, and coordinate them with tile joint locations, as approved by Consultant.

C. **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.

D. **Grout Samples for Initial Selection:** Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.

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 12" x 12" 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 Consultant.

2. Full-size units of each type of trim and accessory for each color required.

F. **Master Grade Certificates:** For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

G. **Product Certificates:** Signed by manufacturers certifying that the products furnished comply with requirements.

H. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.

I. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product 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 Consultants and Employers, and other any information required by Consultant.

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 from site and install permanent works.

G. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements of Division 1 Section "Project Management and Coordination."

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 EXTRA MATERIALS

A. Deliver extra materials to Employer. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
2. Retain below with appropriate definitions in referenced part 1 article.
3. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.
4. 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 Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.

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.

F. **Factory-Applied Temporary Protective Coating:** Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 **TILE PRODUCTS**

A. **General Characteristics:** Tiles are to comply with the following general requirements:

1. Floor Tiles:

a. Abrasive Hardness: Minimum Index 253 to ASTM C 501, unless otherwise specified.

b. Bending Strength: Minimum 35 Kg/cm^2 to ASTM C 648

c. Water Absorption: As specified.

d. Chemical Resistance: Unaffected with moderate acids.

e. Tile Rating: For heavy duty floor by a rating system acceptable to the Consultant.

f. Water Absorption: Maximum 6% to ASTM C 373.

3.1 TERRAZZO TILE

The ingredients of the terrazzo topping finish of the tiles shall confirm the Specification stipulated for in situ Terrazzo finish herein above. The tiles shall be made by mechanical compression process and shall be of first grads. The size shall be 12" x 12" x 1" thick for floor and ½" thick for skirting. The tile shall be composed of one part of cement and two parts of marble chips. The compositions given above applies to 10 mm thickness of the top surface of the tile remaining portion being composed of normal 1:2 cement and course sand mortar. The size and colour composition of the marble chips shall be according to Consultant's instruction. Tiles shall be well shaped perfectly square with straight edges perfectly flat and free from defect which may defect its appearance of serviceability. Tiles with chips or cricks when being installed will not be acceptable. The following samples should be submitted to the Consultant.

Terrazzo tile type	- - -	2 of each
Coloring type	- - -	0.25 kg of each
Cleaning Compound	- - -	1 can of each.

The plain concrete sub-floor surfaces to receive the setting bed for tiles shall be clean and free of dirt, dust, oil or other objectionable matter. Setting beds for terrazzo tile flooring shall be composed of 1 part cement and 2 parts sand by volume with minimum amount of water necessary to produce a workable mass and shall be laid to an average thickness of 25 mm. This shall be covered with neat cement grout of creamy consistency. As large as area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be

less then mm. tiles shall be laid out from the center line of each space outward and in straight lines in a symmetrical pattern with a minimum of cut tiles. Joints between tiles shall be as uniform width. Tile shall be cut with a suitable tool and rough edges shall be rubbed smooth Tile shall be laid to the straight edges.

Floor should be kept wet for 3 days no one should be allowed to walk on tiles during that period.

After seven days of laying the tiles the terrazzo tile floors shall be machine ground to a true even surface using various grades of abrasive stones as required. After the first grinding the floor shall be thoroughly grouted with the same cement and colour composition as used for the manufacture of tiles top surface. The grout shall be of the consistency of thick cream and shall be brushed over the floor to eliminate all blemishes and to thoroughly fill the surface for final grinding. Not less than 72 hours after application, the grouting coat shall be removed by grinding. The final surface should have very smooth finish. Small areas, inaccessible portions and corners which cannot be reached by the grinding machine shall be ground and rubbed by hand. The final gloss should be given polishing the surface to the satisfaction of the consultant

3.2 TERRAZZO SKIRTING TILES

The terrazzo skirting tiles shall be the same as or terrazzo floor tiles except that the skirting tiles shall be 4” x 12” and shall be laid over ½” rough plaster and shall be manufactured and finished in the same manner as the floor tiles.

4.0 FLOOR TILE MEASUREMENT & PAYMENT

Measurement for terrazzo tile shall be made of the net Sq. Ft area on which the terrazzo tile are laid and only approved by the Consultant.

The laid prices tendered for this work shall include the cost of the tiles and all other materials, supplying, mixing and applying, setting bed and slurry, grinding and finishing and of all plant, operation, procedures and requirements necessary of finish this work in accordance with these specification.

4.1 Measurement of terrazzo tile skirting shall be made at the net Rft. Length on which the skirting is laid and duty approved by the Consultant. The Unit Prices tendered for this work shall include the cost of tiles and all other materials, supplying, mixing and applying, setting plaster and slurry curing, grinding and finishing and of all plants, operations, procedures and requirements necessary to finish this work in accordance with these Specifications.

5.0 CONSTRUCTION REQUIREMENTS IN SITU TERRAZZO FLOORING

The floor shall consist of a wearing surface of consistency and net thickness as specified in Bill of Quantities, laid over 1:2:4 concrete base of the specified thickness. The net thickness specified for wearing surface shall be that obtained after grinding and polishing, 1:2:4 concrete shall be mixed and laid in the manner specified for cement concrete floor, using a minimum quantity of water for workability.

The cement concrete shall be leveled with a trowel and straight edge, consolidated and finished with steel trowels to an even but rough surface. The top layer of cement marble chips mixed in the proportion of 1:2 (1 cement and 2 marble Chips) shall be laid over it within 24 hours. The cement and marble chips must be mixed dry in such quantities as are sufficient for a unit of one specified shade. Water shall be added to only such quantities as can be mixed thoroughly and consumed in less than 30 minutes, the quantity of water being the minimum for

workability. Mixing must be done on watertight platform and any mix not used within 30 minutes shall be discarded and removed from site. A layer of cement and marble chipping mixture should be well trowelled into the surface of the base concrete before filling to the top level of the screeds. The layer should be well compacted, and all voids shall be filled in. A layer of neat cement, of the specified colour shall then be well trowelled into the surface leaving a plain smooth surface.

Floors shall be laid in panels of about 4.0'x4'-Q (1.2 x 1.2 meter) or of size as shown on the drawings. Dividing strips of aluminum/brass/glass as specified shall be provided and fixed to exact levels making an allowance for grinding. Aluminum strips shall not be less than 3mm thick and of width equal to the total thickness of cement concrete base and Terrazzo Topping.

Three days after laying the top layer must be evenly and smoothly machine ground with carborandum blocks of coarse, medium and fine grades so as to ensure that all marble chippings are evenly exposed allover the surface. If marble chips are not evenly exposed the Contractor shall pull down the surface and relay it at his own cost. After the first grinding, the floor shall be thoroughly grouted with the same cement and colour composition as specified for the terrazzo mix. The grout shall be of the consistency of thick cream and shall be brushed over the floor to eliminate all impressions and thoroughly fill the surface for final grinding. The surface after grinding shall be left un-disturbed and cured for 2 or 3 weeks, after which it shall be cleaned of dirt and dust by rubbing gently with pumice stone or washing soda in sufficient water. Three days after the surface has been cleaned it shall be rubbed hard with 1:10 solution of oxalic acid using felt. The surface shall then be cleaned and washed with plenty of water. After the surface has dried a

final gloss shall be given by polishing the surface. The walls and all surfaces of the finished works of other trades shall be properly protected from damage and spoiling during the process of grinding and washing of the terrazzo. After the finish grinding has been completed and the surface treatment applied, the terrazzo work shall be covered and protected with approved material until completion of the work of all other trades.

TERRAZZO TILE FLOORING AND CAST IN SITU TERRAZZO

6.0 TERRAZZO DADO AND SKIRTING

The marble chips and cement shall conform to specification for floor. Mixing shall be done in the same manner and proportion. The plastered surface over which the dado/skirting is 'to be applied shall be well roughened and watered; cement mortar of specified ratio shall then be plastered over this well roughened surface to indicated thickness. Before the base course has set the layer of terrazzo mixture shall be well trowelled into the surface of the base to a thickness which after grinding shall result in the finished thickness as per Bill of Quantities. A layer of neat cement of the specified colour shall then be well trowelled into the surface leaving a plain smooth surface. After the period specified for floors above, the Contractor shall start finishing as for floors specified above. Terrazzo skirting shall be provided around all terrazzo floors unless shown otherwise. Skirting and dado shall be straight, level and in plumb. Intersections at floors shall be straight and flush.

7.0 TERRAZZO ON STAIRS

The stair risers and treads shall be finished according to exact sizes including the terrazzo topping making allowance for grinding of terrazzo. The nosing shall be flush with the terrazzo toppings, and shall be protected by aluminum angles as specified or shown on Drawings. The

angles shall be firmly secured, by means of counter-sunk brass screws and cast together with the step.

8.0 MEASUREMENT

Work for floor and dado shall be measured in Sq.Ft. /M of wall and floor area, skirting shall be measured in Lin.Ft./H.

8.1 RATE AND PAYMENT

The rate for all items of work under this section shall cover the cost of furnishing all materials, labour, scaffolding framework laying, curing, grinding, polishing, finishing and appliances at site and performing all operations at any height in accordance with drawings, Bill of Quantities and as specified. The rate shall include the cost of furnishing and installing metal fixings, dividing strips for floors, dados, nosing, angles aluminum U-channels and screws for stairs etc., and providing all assistance to other trades for built in items etc.

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DIVISION 09 91 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 DEFINITIONS

A. **General:** the following coating terms 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 5 and 20 when measured at a 60-degree meter.
3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
4. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.3 SUBMITTALS

A. **Product Data:** For each paint system specified. Include block fillers and primers.

1. Material List: Provide 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: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.

B. **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, the Consultant will furnish color chips for surfaces to be coated.

C. **Samples for Verification:** Of 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 Samples on the following substrates for the Consultant's review of color and texture only:

a. Concrete: Provide two 100-mm- square samples for each color and finish.

b. Ferrous Metal: Provide two 100-mm- square samples of flat metal and two 200-mm- long samples of solid metal for each color and finish.

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 and addresses of Consultants and owners, and other information specified.

E. **Benchmark Samples (Mockups):** Provide a full-coat benchmark finish sample of each type of coating and substrate required on the Project.

1. The Consultant will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.

a. Wall Surfaces: Provide samples on at least 9 sq. m of wall surface.

b. Small Areas and Items: The Consultant will designate an item or area as required.

2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface according to the Schedule or as specified. Provide required sheen, color, and texture on each surface.

a. After finishes are accepted, the Consultant will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from job-applied samples.

E. **Manufacturers Qualifications:** Paint materials shall be the products of paint and coating manufacturers whose qualifications are as follows:

1. Manufacturers shall be reputable of multi-national scale in production and distribution with capabilities to deliver paint materials quantities necessary for the project on due time.

2. Manufacturers shall have evidence from scientific bodies that demonstrate their participation and share in the development of paint industry generally and production of new painting materials kinds.

3. Manufacturers shall have their own proprietary brand names that are well known worldwide.

4. Manufacturers shall have minimum 25 years of successful experience in producing painting materials for use in prestigious projects worldwide of same standard of quality as that intended for the Project.

5. Manufacturers shall be registered in the associations, councils, boards, federations or other similar bodies of paint manufacturers in countries of origin and practice.

F. **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 Consultant's satisfaction.
2. Cleanability: Paint shall not absorb dirt and shall be capable of being washed or scrubbed periodically, to the Consultant'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.
5. Exposure resistance: Paint shall resist yellowing and weathering caused by UV rays and ozone.

G. **Standards:** Paints shall be manufactured to relevant US standards, or any other international standard approved by Authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the 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 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 application.

1.7 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and, in the quantities, described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to the Employer.

1. Quantity: Furnish the Employer with an additional 5 percent, but not less than 3.8L or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 PAINT MATERIALS, GENERAL

A. **General:** Employed paints and painting materials shall be the highest grade and top quality in manufacturer's range of products for the generic kind of paint or paint material.

B. **General:** Materials for paint works shall comply with requirements of BS 6150, as applicable.

C. **Material Compatibility:** Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another, and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

D. **Material Quality:** Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

E. **Colors:** Provide color selections made by the Consultant or by reference to manufacturer's color designations.

2.2 ANTI-CARBONATION PAINT MATERIALS, GENERAL

A. Paint for application on internal and external is to be anti-carbonation paint that is easy to clean, applicable on new or existing concrete, Portland cement plaster or masonry, water-based and nontoxic, allows substrate to breath, Protects substrates form Carbonation, of elastic nature with crack bridging properties.

B. Anti-carbonation paint is to be self-cleaning by application of just sprayed water, highly durable, copolymer-based coating which cures to form a tightly adherent, decorative weatherproof membrane guaranteed for up to 15 years. The formed coating membrane shall tolerate thermal movement in the substrate without splitting or cracking and will retain its elastomeric properties even after prolonged exposure to ultra-violet light. Coating shall have the advantage of being reinforced using glass fiber matting or tapes and shall be capable of bridging cracks or joints between different substrates. The finished surface shall be chemical and pollution-resistant surface that has been specially manufactured to shed dirt, ensuring that it retains a bright, attractive appearance throughout its life. Coating shall be vapor permeable and

allows entrapped substrate moisture to escape without causing blistering or delamination and shall produce an effective barrier to carbon dioxide diffusion and provide reinforced concrete substrates with an excellent defense against the harmful effects of carbonation. Color and sheen shall be selected by the Consultant from manufacturer's full range of products.

C. Anti carbonation paint shall also comply with following properties;

1. Carbon Dioxide Diffusion Resistance, Taywood Method

a. Equivalent Thickness of Air: More than 175 mm.

b. Equivalent Thickness of 30N Concrete: More than 500 mm;

2. Chloride Ion Diffusion Coefficient: No chloride ion diffusion after 60 days; Taywood Method

3. Static Crack Spanning Capability for 200-micron Dry Film Thickness at 23 ºC: Minimum 2.00 mm to ASTM C836.

4. Tear Resistance: 15 N/mm to ASTM D1004.

5. Tensile Strength: 5.00 N/mm2 to ASTM D412.

6. Reduction in Water absorption: Not less than 82% to ASTM C642.

7. Reduction in Chloride Ions Penetration: Not less than 92% to AASHTO M259.

8. Adhesion: Not less than 1.00 N/mm2, BS 1881.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.

1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

2. Start of painting will be construed as the 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 Consultant about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

A. **General:** Preparation of surfaces to receive paints is to be according with requirements of BS 6150 and recommendations of paints manufacturer.

B. **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 the 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.

C. **Cleaning:** Before applying paint or other surface treatments, clean the substrates of substances that could impair the 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.

D. **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. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel 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. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.

3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreignsubstances. Use solvent or mechanical cleaning methods that comply with recommendations of referenced standards.

a. Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of referenced standards.

b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

c. 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 the same primer as the shop coat.

4. 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.

E. **Materials 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.

F. **Tinting:** Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the 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 recommendations of BS 6150 and 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 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, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the 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. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
10. 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 the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

2. Omit primer on metal surfaces that have been shop primed and touchup painted.
3. 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 edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the 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 the type of material applied. Use brush of appropriate size for the surface or item being painted.
2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. **Minimum Coating Thickness:** Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. **Mechanical and Electrical Work:** Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. **Prime Coats:** Before applying finish coats, apply a prime coat of material, as recommended by the 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. The Employer reserves the right to invoke the following test procedure at any time and as often as the Employer deems necessary during the period when paint is being applied:

1. The Employer will engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in the presence of the Contractor.

2. The testing agency will perform appropriate tests for the following characteristics as required by the Employer:

a. Quantitative material analysis.

b. Abrasion resistance.

c. Apparent reflectivity.

d. Flexibility.

e. Washability.

f. Absorption.

g. Accelerated weathering.

h. Dry opacity

i. Accelerated yellowness.

j. Recoating.

k. Skinning

l. Color retention.

m. Alkali and mildew resistance.

3. The Employer may direct the Contractor to stop painting if test results show material being used does not comply with specified requirements. The Contractor shall remove noncomplying paint from the site, pay for testing, and repaint surfaces previously coated with the rejected paint. If necessary, the Contractor may be required to remove rejected paint from previously painted surfaces if, on repainting with specified paint,

the 2 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 the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.6 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Consultant.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

3.7 EXTERIOR PAINT SCHEDULE

A. Coordinate the following paint coats with surface preparation steps as specified.

B. Concrete and Cement Sand Portland Plaster: Provide the following finish system over exterior concrete and Portland Cement Plaster.

1. Light Textured Emulsion Paint

a. 100% pure acrylic-based paint specially formulated for external application. The paint is to dry by evaporation of water and will produce a durable, flexible, excellent water and alkali resistant and is to provide long lasting protection for coated surfaces. The paint is to be UV-resistant, of high bond strength to substrates and distinguished color retention, and is to provide anti-carbonation shield for the substrate while allowing moisture of substrate to escape to the outside.

b. Finished surface is to be of light texture.

C. **Ferrous Metal:** Provide the following finish system over exterior ferrous metal.

1. Full-Gloss, Epoxy-Based Enamel: Two finish coat over primer.

a. Primer: High-molecular-weight, epoxy-resin primer at spreading rate recommended by manufacturer.

b. Finish Coat: High-molecular-weight, epoxy-resin topcoat at spreading rate recommended by the manufacturer.

c. Protection Coating: Two Coats of clear polyurethane-based, UV resistant protection coating.

3.8 INTERIOR PAINT SCHEDULE

A. Coordinate the following paint coats with surface preparation steps as specified.

B. Concrete: Provide the following paint systems over interior concrete and masonry surfaces

1. Flat Acrylic Finish: 2 finish coats over a primer.

a. 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 0.025 mm.

2. 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 0.060 mm per coat.

C. **Plaster:** Provide the following finish systems over new, interior Portland cement plaster surfaces:

1. Flat Acrylic Finish: 2 finish coats over a primer.

a. 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 0.036 mm.

b. Undercoat: same material for finish coats specified hereafter diluted to the manufacturer's recommendations.

c. 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 0.064 mm per coat.

2. Semigloss, Alkyd-Enamel Finish: One finish coat over an undercoat and a primer.

a. Primer: Alkali-resistant, alkyd- or latex-based, interior primer, 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 1.2 mils (0.031 mm).

b. First and Second Coats: Semigloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.066 mm.

D. **Woodwork and Hardboard:** Provide the following paint finish systems over new, interior wood surfaces:

1. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a wood undercoater.

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 0.031 mm.

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 0.066 mm.

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 0.031 mm.

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 0.061 mm.

E. **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.

F. **Zinc-Coated Metal:** Provide the following finish systems over zinc-coated metal:

1. Full-Gloss, Alkyd-Enamel Finish: One finish coat over an enamel undercoat and a primer.

a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

b. Undercoat: Alkyd, interior enamel undercoat or semigloss, interior, alkyd-enamel finish coat, 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 0.031 mm.

c. Finish Coat: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

G. **Ferrous Metal:** Provide the following finish systems over ferrous metal:

1. Full-Gloss, Alkyd-Enamel Finish: two finish coat over a primer.

a. Primer: Interior ferrous-metal primer at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

b. Finish Coat: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm percoat.

H. **Ferrous Metal:** Provide the following finish systems over ferrous metal:

1. Full-Gloss, Epoxy-Based Enamel: Two finish coat over primer.

a. Primer: High-molcular-weight, epoxy-resin primer at spreading rate recommended by manufacturer.

b. Finish Coat: High-molcular-weight, epoxy-resin topcoat at spreading rate recommended by the manufacturer.

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DIVISION 10 28 00

TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Toilet and bath accessories.
2. Warm-air dryers..

1.3 SUBMITTALS

A. **Product Data:** Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.

B. **Samples:** For each accessory item to verify design, operation, and finish requirements.

1. Approved full-size Samples will be returned and may be used in the Work.

C. **Setting Drawings:** For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.

D. **Product Schedule:** Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use designations indicated in the Toilet and Bath Accessory Schedule and room designations indicated on Drawings in product schedule.

E. **Maintenance Data:** For accessories to include in maintenance manuals specified in Division

1. Provide lists of replacement parts and service recommendations.

1.4 QUALITY ASSURANCE

A. **Product Options:** Accessory requirements, including those for materials,

finishes, dimensions, capacities, and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule.

1. Products of other manufacturers listed in Part 2 with equal characteristics, as judged solely by Consultant, may be provided.
2. Other manufacturers' products with equal characteristics may be considered. See Division 1 Section "Substitutions."
3. Do not modify aesthetic effects, as judged solely by Consultant, except with Consultant's approval. Where modifications are proposed, submit comprehensive explanatory data to Consultant for review.

1.5 WARRANTY

A. **General Warranty:** 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.

B. **Manufacturer's Mirror Warranty:** Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.

1. Minimum Warranty Period: 15 years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MATERIALS

A. **Stainless Steel:** ASTM A 666, Type 304, with No. 4 finishes (satin), in 0.8-mm minimum nominal thickness, unless otherwise indicated.

B. **Brass: ASTM B 19, leaded** and unleaded flat products; ASTM B 16M, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.

C. **Sheet Steel:** ASTM A 366/A 366M, cold rolled, commercial quality, 0.9-mm minimum nominal thickness; surface preparation and metal

pretreatment as required for applied finish.

D. Galvanized Steel Sheet: ASTM A 653/A 653M, Z180.

E. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal**.**

F. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.

G. Mirror Glass: as per requirements of Division 8, section "Mirrored Glass".

H. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

I. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed**.**

2.2 FABRICATION

A. **General:** Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

B. **Surface-Mounted Toilet Accessories:** Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.

C. **Recessed Toilet Accessories:** Unless otherwise indicated, fabricate units of all- welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.

D. **Mirror-Unit Hangers:** Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:

1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
2. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

E. **Keys:** Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Employer's representative.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.

3.2 ADJUSTING AND CLEANING

A. Remove temporary labels and protective coatings.

B. Clean and polish exposed surfaces according to manufacturer's written recommendations.

3.3 TOILET AND BATH ACCESSORY SCHEDULE

A. **Toilet Tissue Dispenser (Toilet Paper Holder):** Provide toilet tissue dispenser complying with the following:

1. Type Single-roll dispenser.
2. Mounting: Surface mounted with concealed anchorage.
3. Material: Stainless steel
4. Operation: Non-control delivery with mfr's standard spindle.
5. Capacity: Designed for standard diameter-core tissue rolls up to 140

mm diameter (800 sheets)

B. **Soap Dish:** Stainless steel size and shape as selected by the Consultant from manufacturer's standard range.

C. **Soap Dispenser:** Provide soap dispensers complying with the following:

Liquid Soap Dispenser, Vertical-Tank Type: Wall mounted type, minimum 1182.9 ml capacity tank with stainless steel piston, springs, and internal parts designed to dispenses soap in measured quantity by pump action, and stainless-steel cover with unbreakable window-type refill indicator.

Mounting: Designed for wall mounting.

Soap Valve: Designed for dispensing soap in liquid form.

D. **Paper Towel Dispenser:** 800 multi-hold towels capacity, stainless steel, surface mounted.

E. **Robe Hook**

1. Stainless steel.
2. Double- prong with rectangular wall bracket and back plate for concealed mounting.

F. **Grab Bar**

1. Surface mounting, exposed.
2. Stainless steel.
3. 38 mm outside diameter and 1.20 mm minimum wall thickness and 38 mm distance from inside of bar and face of wall.
4. Furnish complete with two end flanges, 3 mm thick minimum and 76 mm diameter, each of three countersunk screw holes for attachment to walls.
5. Use of flanges with snap covers is acceptable.

G. **Warm-Air Dryer:** Provide warm-air dryer complying with the following:

1. Touch-Button-Activated Hand Dryer: Surface-mounted, warm-air hand dryer activated by touch button and with manufacturers' standard, white-painted metal cover and 30-second-timed power cut-off switch.

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