

SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies demolition and removal of buildings, portions of buildings, and utilities.

1.2 RELATED WORK:

- A. Demolition and removal of walks, curbs, and on-grade slabs outside buildings to be demolished: Section 31 20 00, EARTH MOVING.
- B. Safety Requirements: GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- C. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.
- E. Asbestos Removal: Section 02 82 11 TRADITIONAL ASBESTOS ABATEMENT.
- F. Construction Waste Management: Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.
- G. Infectious Control: Section 01 00 00, GENERAL REQUIREMENTS, Article, INFECTION PREVENTION MEASURES.

1.3 PROTECTION:

- A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. Comply with requirements of GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations. Comply with requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES AND IMPROVEMENTS.
- C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.
- D. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in

hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.

- F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
 - 1. No wall or part of wall shall be permitted to fall outwardly from structures.
 - 2. Maintain at least one stairway in each structure in usable condition to highest remaining floor. Keep stairway free of obstructions and debris until that level of structure has been removed.
 - 3. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
 - 4. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Medical Center; any damaged items shall be repaired or replaced as approved by the Resident Engineer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have Resident Engineer's approval.
- H. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article, INFECTION PREVENTION MEASURES.

1.4 UTILITY SERVICES:

- A. Demolish and remove outside utility service lines shown to be removed.
- B. Remove abandoned outside utility lines that would interfere with installation of new utility lines and new construction.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION****3.1 DEMOLITION:**

- A. Completely demolish and remove buildings and structures, including all appurtenances related or connected thereto, as noted below:
 - 1. To extent indicated on drawings and as required for installation of new work.
 - 2. To full depth within an area defined by hypothetical lines located 1500 mm (5 feet) outside building lines of new structures.
- B. Debris, including brick, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by him daily, off the Medical Center to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Resident Engineer. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.
- C. Items indicated to be salvaged for owner are to be dismantled carefully and delivered to VA at specified on-campus location.
- D. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state or local permits, rules and/or regulations. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.
- E. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Resident Engineer. When Utility lines are encountered that are not indicated on the drawings, the Resident Engineer shall be notified prior to further work in that area.
- F. Do not abandon ductwork, pipes, conduits and other miscellaneous utility items in place. All items to be removed shall be removed to the full extent of their respective terminations.

- G. Contractor is responsible for maintaining the integrity of all rated assemblies including and not limited to walls, floors, and rated encasements for structural elements. Where penetrating items are removed at rated assemblies, the assembly shall be restored in manners complying with approved listed assemblies for hourly ratings required as shown on the Life Safety Plan and as required for the IBC and NFPA codes Type of Construction indicated.
- H. Commence patching of rated assemblies at the earliest possible time. Upon the written approval of the COTR, the Contractor may postpone the patching of rated assemblies as needed to accommodate construction activities.

3.2 CLEAN-UP:

On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to Resident Engineer. Clean-up shall include off the Medical Center disposal of all items and materials not required to remain property of the Government as well as all debris and rubbish resulting from demolition operations.

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SECTION 02 82 11
ASBESTOS ABATEMENT PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. ZGA Architects & Planners has developed through its consultant, Materials Testing & Inspection, this technical specification section for the removal of the asbestos containing materials identified herein. This section is intended to govern the removal of asbestos identified within this project. This section makes mention to various Federal documents, all of which are available for review at MTI.
- B. It is incumbent upon the bidding contractor to satisfy him or her, regarding the quantity of asbestos to be removed and the conditions thereof.

1.2 PROJECT/WORK IDENTIFICATION

A. GENERAL

- 1. Project name is **Replace and Modernize Surgery / Intensive Care Unit**, Building 85, Boise, Idaho as shown on contract documents prepared by ZGA Architects & Planners. ZGA Architects & Planners is herein referred to as "Owner's Representative". Materials Testing & Inspection is referred to as Owner's Consultant. The Asbestos Abatement Contractor is herein referred to as the "Contractor".
- 2. This Project involves the removal of roughly 30 linear feet of six (6) inch diameter AC Pipe attached to the exterior of building 85. The Project Manual for non-asbestos portions of the project is found under separate cover. References to sections not included in this document can be found in the Project Manual.

1.3 SUMMARY:

- A. This Section specifies administrative and supervisory requirements necessary for project coordination.
- B. PROJECT SUPERVISOR (Contractor/Supervisor):
 - 1. Provide a full-time project supervisor who is experienced in administration and supervision of Asbestos abatement projects including work practices, protective measures for building and personnel, disposal procedures, etc. This person is the Contractor's representative responsible for compliance with all applicable federal, state, and local regulations, particularly those relating to asbestos containing building materials.
 - 2. Certification: The project supervisor must hold as a minimum, a current AHERA Contractor/Supervisor Certificate. A copy of all certificates and cards shall be on file with the Boise-VAMC prior to

the initiation of the project. The workers must hold as a minimum current AHERA worker certificates and medical approvals.

C. CONTINGENCY PLAN:

1. Contingency plan: Prepare a contingency plan for emergencies including fire, accident, power failure, pressure differential system failure, supplied air system failure, or any other event that may require modification or abridgment of decontamination or work area isolation procedures. Include in the plan specific procedures for decontamination or work area isolation. Note that nothing in this specification should impede safe exiting or provision of adequate medical attention in the event of an emergency.
2. Emergency Numbers: Post in the clean room of personnel decontamination unit telephone numbers and locations of emergency services including but not limited to hospital, police department, fire department, and poison control center.

D. NOTIFICATIONS:

1. Notify other entities at the job site of the nature of the Asbestos abatement activities, location of asbestos containing materials, requirements relative to Asbestos set forth in these specifications, and applicable regulations.
2. The Contractor is required to notify, in writing, emergency response service providers of the type and duration of work to be completed. This notification shall be made prior to the initiation of work.
3. Notifications of Emergency: Any individual at the job site may notify emergency service agencies if necessary without effect on this Contract or the Contract Sum.
4. Multi-employer Work Sites: The contractor must inform other employers on site of the Asbestos work that will be conducted and take measures to ensure that the employees are not exposed to asbestos.
5. A copy of the demolition/renovation notice shall be submitted as required by 40 CFR 61 Subparts M, National Emission Standard for Asbestos. Send the notice to the following agencies:
 - a. Environmental Protection Agency
 - b. The applicable State entities
6. The notification forms shall be completed and submitted by the Contractor for abatement projects that are not covered under 40 CFR 61 Subparts A and M. All other agencies, regional or local, having jurisdiction over this project must be notified.
7. Documentation that arrangements for the transport and disposal of Asbestos containing or contaminated materials and supplies have been

made must be submitted. The name and location of the disposal site, a copy of handling procedures and a list of protective equipment utilized for Asbestos disposal at the landfill, prepared and signed by the landfill Owner, shall be obtained and submitted.

E. TECHNICAL SUPPORT:

1. Air monitoring for Asbestos required by OSHA is the work of the Contractor. Identify an Industrial Hygiene consultant for technical support and guidance. Provide copies of their training and qualifications meeting the following:
 - a. Experience: Have at least 2 years of asbestos related experiences
 - b. Accreditation: Have a current EPA-AHERA Asbestos Contractor/Supervisor certificate

F. ABATEMENT. This section covers the abatement of potential hazards relating to materials that contain asbestos in the areas described in this specification.

1.4 DESCRIPTION OF WORK

- A. All work shall be performed by a certified Asbestos Abatement Contractor in general accordance with 40 CFR Part 61, Subpart M, NESHAP, and OSHA regulation 29 CFR Part 1926.1101, Asbestos and applicable local and state regulations. All work shall be performed in accordance with VA Guidelines, therefore any Class II work shall be performed in a glove bag or within a mini-enclosure.
- B. Work. The Concrete Asbestos Pipe (AC Pipe) is to be capped in preparation for the sewer line to be re-routed for building 85 the abandoned sewer line existing within the footprint of the future building will be removed and properly disposed. The extent of ACM to be removed shall be determined during the removal project. It is believed that approximately 30 linear feet of AC Pipe will be removed. Polyethylene sheeting will be placed under the pipe prior to cutting or breaking of pipe to capture the associated debris. The AC pipe shall be wrapped prior to removal from the trench.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

- A. Products used shall be provided in accordance with 40 CFR Part 61, Subpart M, NESHAP, and OSHA regulation 29 CFR Part 1926.1101, Asbestos and general industry standards.

PART 3 - EXECUTION

3.1 GENERAL ASBESTOS REMOVAL

- A. Adequate wetting. The asbestos-containing material shall be sprayed, injected or otherwise adequately wetted with amended water in general accordance with the NESHP Adequately Wet Guidance (40 CFR Part 61, Subpart M). If sprayed, a fine low-pressure spray shall be applied to minimize fiber emission during the spraying. Particular care shall be taken to avoid release of asbestos through substrate penetrations or containment barrier openings.
- B. Removal. Removal of the asbestos-containing material shall be done in small sections. Particular care shall be taken to avoid release of asbestos through substrate penetrations or containment barrier openings. Asbestos-containing materials shall be removed while wet.
- C. Surface cleaning. After completion of gross asbestos removal work, all surfaces from which asbestos has been removed shall be wire-brushed and/or wet-scrubbed, or cleaned by an equivalent method, to remove all visible asbestos-containing material. During this work, the surfaces being cleaned shall be kept wet whenever feasible.
- D. Sealing (Lock-down encapsulation). Lock down any residual asbestos fibers which may remain on all surfaces from which asbestos has been removed with an encapsulant sealer.
 - 1. Coverage rate. Use the coverage rate specified in the Underwriters Laboratories listing or certification, or the manufacturer's instructions, whichever is greater.
 - 2. Effectiveness. Apply the encapsulant in a manner which does not degrade the function of any replacement material. In particular, for replacement fireproofing, apply the encapsulant so that the replacement fire-resistive assembly conforms to the requirements (e.g., rating) of this specification and existing building conditions and requirements.
- E. MINI-ENCLOSURE:
 - 1. Remove non-friable asbestos-containing material within a mini-enclosure according to the following procedure:
 - a. Completely separate the work area from other portions of the building by providing double sheet plastic barriers at least 6-mil in thickness. Seal the perimeter of all sheet plastic barriers with duct tape and spray cement. Stagger seams so that the top layer can be removed independently of the bottom layer.
 - b. Work Room: Construct Work Room in the same manner as a Primary Barrier fabricated from 6-mil polyethylene sheeting. Arrange so that Primary Barrier provides both a Critical and Primary Barrier.

Line walls and floor of Work Room with a continuous Secondary Barrier.

- c. Change Room: Provide an approximately 3'-0" by 3'-0" Change Room, with additional space as required for storage, attached to each Work Room. Fabricate Change Room from 6-mil polyethylene sheeting in the same manner as a Primary Barrier. Locate so that access to Work Area is through Change Room.
- d. Step Off Area: Cover floor in front of entry to Change Room with one layer of 6-mil polyethylene sheeting. Securely anchor sheet plastic to prevent slipping.
- e. Door Construction: Doors shall be constructed at the Change Room entry and entry from Change Room to Work Room. These flaps must be secured to prevent leakage outside the enclosure.
- f. A HEPA filtered vacuum cleaner, located outside mini-enclosure, may be used to establish negative pressure. Provide a minimum of four (4) air changes per hour in the Work Room.

3.2 CONCRETE ASBESTOS PIPE

- A. Concrete Asbestos Pipe (AC Pipe or Transite™) is considered by NESHAP regulations to be a Category II non-friable material. That is, this asbestos containing material, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure. Category II materials must be removed prior to demolition or renovation if it is believed that they will be damaged and become friable as a result of construction activities.
- B. Polyethylene surfaces. Where plastic surfaces are used, the enclosure shall be made using one or more layer of 6-mil (0.15 mm) or thicker polyethylene plastic sheeting to enclose sections of the material. Plastic sheets shall be sealed water-tight by overlapping by at least 6 inches (15 cm) or more and sealing the seams with adhesive and duct tape.
- C. The AC Pipe is to be capped in preparation for the sewer line to be re-routed for building 85, the abandoned sewer line existing within the footprint of the future building will be removed and properly disposed. The extent of ACM to be removed shall be determined during the removal project. It is believed that approximately 30 linear feet of AC Pipe will be removed. Polyethylene sheeting will be placed under the pipe prior to cutting or breaking of pipe to capture associated debris. The AC pipe shall be wrapped prior to removal from the trench.
- D. Wetting. The wand of a low pressure spray unit, or of an injection unit, delivering amended water, shall be used to wet the surface of the CAB to prevent fugitive dust.

E. Cleanup. Cleanup shall be as provided per Section 3.3.

F. Disposal. Disposal shall be as provided per Section 3.3.

3.3 CLEANUP

A. Bagging.

1. Procedures. The asbestos-containing material shall be packed and sealed in asbestos-labeled plastic bags either in the work area or in a negative pressure, HEPA-filtered enclosure and decontamination unit around any vacuum transfer or other waste collection equipment located outside the work area, except as provided below. The sealed plastic bags shall be placed into asbestos-labeled containers and may be either transported immediately or stored temporarily in the work area or other negative pressure, HEPA-filtered enclosure for later transport.
2. Labeling. Asbestos waste containers shall be labeled, except for nonfriable asbestos-containing waste that has not been and does not have a high probability of becoming, crumbled, pulverized, or reduced to powder, which need not be labeled.
3. Surface cleaning. After completion of gross asbestos removal work, all surfaces from which asbestos has been removed shall be wire-brushed and/or wet-scrubbed, or cleaned by an equivalent method, to remove all visible asbestos-containing material. During this work, the surfaces being cleaned shall be kept wet whenever feasible.
4. Decontamination. All materials, equipment, tools and bagged wastes taken from the work area or other negative pressure, HEPA-filtered enclosure after the initiation of asbestos removal work shall be thoroughly decontaminated as follows:
 - a. Gross cleaning. Workers shall remove gross contamination from tools, equipment, building components, waste bags, and other materials before these items leave the work area. Workers proceed to the contaminated/equipment room where they shall wash these items.
 - b. Washing. After washing, tools, equipment and other materials are passed into the shower room, where they may be re-washed if necessary to remove visible debris, in the shower. Tools, equipment and materials are passed from the shower room into the equipment/waste removal room and then outside the decontamination enclosure.
 - c. Bagged waste. Workers shall remove gross contamination from the bagged waste before leaving the work area. Workers take bagged waste to the contaminated/equipment room, where the bags are wet-cleaned. After the bagged waste is wet-cleaned in the

contaminated/equipment room, the bags shall be handed into the shower room where they shall be placed in a second, clean labeled plastic bag, sealed, washed, and handed into the equipment/waste removal room, or washed and handed into the equipment/waste removal room to be placed into clean labeled drums. The waste material in sealed double containers (two bags, or a bag and a drum) is passed from the equipment/waste removal room to outside the decontamination enclosure.

- d. Containerized bagged waste. Waste which has been deposited directly (e.g., by vacuum transfer) into a bag which is in a transport vehicle, which has not contaminated the outside of the bag, and which needs no further on-site handling prior to transport from the work site, shall be sealed in the bag, checked for surface contamination, wet cleaned and, if appropriate, HEPA vacuumed if such contamination is found, and transported from the site.

B. Disposal.

1. Packaging. Prior to post-abatement inspection, all asbestos-containing waste shall be packaged in sealed double containers and removed from the work area to a specified transportation vehicle or a designated holding area approved by the Owner's Representative. The outer container may be either a clean sealed drum (steel or fiber) or a sealed plastic bag. The inner container shall be a sealed plastic bag at least 6 mil (0.15 mm) thick.
2. OSHA/EPA labeling. Asbestos warning labels having permanent adhesive and waterproof print, or being permanently printed on the container, shall be affixed to the outside of all asbestos containers, and each inside bag, except that nonfriable asbestos-containing waste that has not been and does not have a high probability of becoming, crumbled, pulverized, or reduced to powder need not be labeled.
3. DOT labeling and marking. A DOT "class 9" shipping label and DOT mark shall be applied to or be printed on each packaging of asbestos-containing materials; except for nonfriable asbestos-containing materials that did not become crumbled, pulverized, or reduced to powder; or a limited quantity of asbestos-containing material which is not being transported by air.
4. EPA vehicle marking. Each vehicle transporting asbestos-containing waste shall be marked with asbestos danger signs during loading and unloading of the waste, in accordance with the NESHAP, 40 CFR 61.150(c).

5. Temporary storage.
 - a. Authorization. Temporary storage of sealed double containers of asbestos waste outside the decontamination enclosure may be permitted, upon approval of the procedures by the Owner's Representative.
 - b. Procedure. After the sealed double containers have been passed out of the decontamination enclosure or the containment barrier, they shall immediately be placed in a cart lined with at least one layer of 6 mil (0.15 mm) plastic sheeting. When a sufficient number of containers have accumulated, but not more than fill the cart, and no more than 15 minutes after loading the first container onto the cart, the cart shall be taken to a specified transportation vehicle or a designated holding area and the containers shall be placed therein.
6. Vehicle marking. Each cart transporting asbestos-containing waste outside the work area (whether to temporary storage or to the transportation vehicle), and each transportation vehicle shall be marked with asbestos danger signs during waste loading and unloading in accordance with 40 CFR 61.150(c).
7. Protection. Workers entering a decontamination enclosure to remove waste material shall follow the provisions of this contract for donning protective equipment and exiting the work area or decontamination chamber.
8. Asbestos waste shipment records.
 - a. Preparation. The Contractor shall prepare the waste shipment records. Upon submitting each waste shipment record for a shipment of asbestos waste to the Owner's Representative for signature, the Contractor shall make available the transport vehicle and the asbestos waste packages for inspection by the Owner's Representative so that the Owner's Representative can check for significant discrepancies in the amount of waste (for example, number of bags or drums, or volume of waste) and its condition (for example, whether the bags or drums appear to be sealed and not leaking).
 - b. Initially-signed records. The Contractor shall provide asbestos waste shipment record(s) signed by the Owner's Representative, the Contractor and the initial transporter to the Owner's Representative when asbestos wastes are removed from the facility property.
 - c. Depositing. Asbestos waste shall be deposited as soon as practical at a regulated waste disposal site, except for EPA

"Category I" nonfriable ACM (packing, gasket, resilient floor covering, or asphalt roofing product ACM) that has not become friable, nor will be or has been sanded, ground, cut, or abraded.

- d. Providing completely-signed records. Completed waste shipment record(s) signed by the Contractor, all transporter(s), transferor(s), disposal and/or conversion facility(ies), shall be provided to the Owner's Representative within 30 days of the time at which the asbestos-containing wastes are received at the disposal and/or conversion facility(ies), which shall be no longer than 40 days after the waste was accepted by the initial transporter.
- e. Waste conversion. If any asbestos-containing waste is converted to asbestos-free material in accordance with 40 CFR 61.155, completed certificate(s) of conversion, signed by the Contractor and the conversion facility(ies), shall be provided to the Owner's Representative within 35 days of the time at which the asbestos-containing waste is converted, which shall be no longer than 45 days after the waste was accepted by the initial transporter.

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**SECTION 03 30 00
CAST-IN-PLACE CONCRETE**

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies cast-in-place structural concrete and materials and mixes for other concrete.

1.2 RELATED WORK:

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Concrete roads, walks, and similar exterior site work: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

1.3 TESTING AGENCY FOR CONCRETE MIX DESIGN:

- A. Testing agency retained and reimbursed by the Contractor and approved by Resident Engineer.
- B. Testing agency maintaining active participation in Program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology.
- C. Testing agency shall furnish equipment and qualified technicians to establish proportions of ingredients for concrete mixes.

1.4 TOLERANCES:

- A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is +0 mm (+0 inch) and -20 mm (-3/4 inch).
- B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for metric bar sizes Nos. 10, 13, and 16 (English size Nos. 3, 4, and 5) (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 mm (+0 inch) and -13 mm (-1/2 inch) where gross bar length is less than 3600 mm (12 feet), or +0 mm (+0 inch) and -20 mm (-3/4 inch) where gross bar length is 3600 mm (12 feet) or more.
- C. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +20 mm (+3/4 inch) and - 6 mm (-1/4 inch). Tolerance of thickness of beams more than 300 mm (12 inch) but less than 900 mm (3 feet) is +20 mm (+3/4 inch) and -10 mm (-3/8 inch).
- D. Slab Finishes: ACI 117, Section 4.5.6, F-number method in accordance with ASTM E1155, except as follows:
 - 1. Test entire slab surface, including those areas within 600 mm (2 feet) of construction joints and vertical elements that project through slab surface.
 - 2. Maximum elevation change which may occur within 600 mm (2 feet) of any column or wall element is 6 mm (0.25 inches).

3. Allow sample measurement lines that are perpendicular to construction joints to extend past joint into previous placement no further than 1500 mm (5 feet).

1.5 REGULATORY REQUIREMENTS:

- A. ACI SP-66 - ACI Detailing Manual.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI 301 - Standard Specifications for Structural Concrete.

1.6 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:
 1. Reinforcing steel: Complete shop drawings
 2. Construction Joint Layout: Dimensioned, for foundations, slabs on grade, and concrete topping over metal deck.
- C. Mill Test Reports:
 1. Reinforcing Steel.
 2. Cement.
- D. Manufacturer's Certificates:
 1. Lightweight aggregate for structural concrete.
 2. Air-entraining admixture.
 3. Chemical admixtures, including chloride ion content.
 4. Sheet Materials for curing concrete.
 5. Liquid membrane-forming compounds for curing concrete.
 6. Non-shrink grout.
 7. Expansion joint filler.
 8. Adhesive binder.
 9. Vapor Barrier
- E. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians, documentation of relevant equipment availability and calibrations, and evidence of active participation in program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology.
- F. Test Report for Concrete Mix Designs: Trial mixes including compressive strength, water-cement ratio curves, concrete mix ingredients, and admixtures.
- G. Pre-concrete Conference: Meeting minutes

1.7 DELIVERY, STORAGE, AND HANDLING:

- A. Conform to ACI 304. Store aggregate separately for each kind or grade, to prevent segregation of sizes and avoid inclusion of dirt and other materials.

- B. Deliver cement in original sealed containers bearing name of brand and manufacturer, and marked with net weight of contents. Store in suitable watertight building in which floor is raised at least 300 mm (1 foot) above ground. Store bulk cement and fly ash in separate suitable bins.
- C. Deliver other packaged materials for use in concrete in original sealed containers, plainly marked with manufacturer's name and brand, and protect from damage until used.

1.8 PRE-CONCRETE CONFERENCE:

- A. General: At least 15 days prior to submittal of design mixes, conduct a meeting to review proposed methods of concrete construction to achieve the required results.
- B. Agenda: Includes but is not limited to:
 - 1. Submittals.
 - 2. Coordination of work.
 - 3. Availability of material.
 - 4. Concrete mix design including admixtures.
 - 5. Location of construction joints in foundations, slabs on grade, and concrete topping over metal deck.
 - 6. Methods of conveying, placing, finishing, and curing.
 - 7. Finish criteria required to obtain required flatness and levelness.
 - 8. Timing of floor finish measurements.
 - 9. Material inspection and testing.
- C. Attendees: Include but not limited to representatives of Contractor; subcontractors involved in supplying, conveying, placing, finishing, and curing concrete; lightweight aggregate manufacturer; admixture manufacturers; Resident Engineer; Consulting Engineer; Department of Veterans Affairs retained testing laboratories for concrete testing and finish (F-number) verification.
- D. Minutes of the meeting: Contractor shall take minutes and type and distribute the minutes to attendees within five days of the meeting.

1.9 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Concrete Institute (ACI):
 - 117-10.....Tolerances for Concrete Construction and
Materials
 - 211.1-91(R2009).....Selecting Proportions for Normal, Heavyweight,
and Mass Concrete
 - 211.2-98(R2004).....Selecting Proportions for Structural Lightweight
Concrete

- 214R-02.....Evaluation of Strength Test Results of Concrete
- 301-10.....Structural Concrete
- 304R-00(R2009).....Guide for Measuring, Mixing, Transporting, and
Placing Concrete
- 305R-10.....Hot Weather Concreting
- 306R-10.....Cold Weather Concreting
- 308R-01(R2008).....Standard Practice for Curing Concrete
- 309R-05.....Guide for Consolidation of Concrete
- 318-08.....Building Code Requirements for Reinforced
Concrete and Commentary
- 347-04.....Guide to Formwork for Concrete
- SP-66-04.....ACI Detailing Manual
- C. American National Standards Institute and American Hardboard Association
(ANSI/AHA):
- A135.4-2004.....Basic Hardboard
- D. American Society for Testing and Materials (ASTM):
- A615/A615M-09.....Deformed and Plain Billet-Steel Bars for
Concrete Reinforcement
- A653/A653M-09.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-
Iron Alloy-Coated (Galvannealed) by the Hot-Dip
Process
- A706/A706M-09.....Low-Alloy Steel Deformed and Plain Bars for
Concrete Reinforcement
- A767/A767M-09.....Zinc-Coated (Galvanized) Steel Bars for Concrete
Reinforcement
- A820-06.....Steel Fibers for Fiber-Reinforced Concrete
- C31/C31M-09.....Making and Curing Concrete Test Specimens in the
field
- C33-08.....Concrete Aggregates
- C39/C39M-09.....Compressive Strength of Cylindrical Concrete
Specimens
- C94/C94M-09.....Ready-Mixed Concrete
- C143/C143M-10.....Slump of Hydraulic Cement Concrete
- C150-09.....Portland Cement
- C171-07.....Sheet Materials for Curing Concrete
- C172-08.....Sampling Freshly Mixed Concrete
- C173-10.....Air Content of Freshly Mixed Concrete by the
Volumetric Method
- C192/C192M-07.....Making and Curing Concrete Test Specimens in the
Laboratory

- C231-09.....Air Content of Freshly Mixed Concrete by the Pressure Method
- C260-06.....Air-Entraining Admixtures for Concrete
- C309-07.....Liquid Membrane-Forming Compounds for Curing Concrete
- C330-09.....Lightweight Aggregates for Structural Concrete
- C494/C494M-10.....Chemical Admixtures for Concrete
- C618-08.....Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
- C666/C666M-03.....Resistance of Concrete to Rapid Freezing and Thawing
- C881/C881M-02.....Epoxy-Resin-Base Bonding Systems for Concrete
- C1107/1107M-08.....Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- C1315-08.....Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
- D297-93(R2006).....Rubber Products-Chemical Analysis
- D1751-04(R2008).....Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
- D4397-09.....Polyethylene Sheeting for Construction, Industrial and Agricultural Applications
- E1155-96(R2008).....Determining F_F Floor Flatness and F_L Floor Levelness Numbers
- E. American Welding Society (AWS):
- D1.4/D1.4M-11.....Structural Welding Code - Reinforcing Steel
- F. Concrete Reinforcing Steel Institute (CRSI):
- Handbook 2008
- G. U.S. Department of Commerce Product Standard (PS):
- PS 1.....Construction and Industrial Plywood
- PS 20.....American Softwood Lumber

PART 2 - PRODUCTS:

2.1 FORMS:

- A. Wood: PS 20 free from loose knots and suitable to facilitate finishing concrete surface specified; tongue and grooved.
- B. Plywood: PS-1 Exterior Grade B-B (concrete-form) 16 mm (5/8 inch), or 20 mm (3/4 inch) thick for unlined contact form. B-B High Density Concrete Form Overlay optional.
- C. Metal: Steel (removal type) of suitable weight and form to provide required rigidity.

- D. Permanent Steel Form for Concrete Slabs: As specified in Section 05 36 00, COMPOSITE METAL DECKING.
- E. Corrugated Fiberboard Void Boxes: Double faced, completely impregnated with paraffin and laminated with moisture resistant adhesive, size as shown. Design forms to support not less than 48 KPa (1000 psf) and not lose more than 15 percent of their original strength after being completely submerged in water for 24 hours and then air dried.
- F. Form Ties: Develop a minimum working strength of 13.35 kN (3000 pounds) when fully assembled. Ties shall be adjustable in length to permit tightening of forms and not have any lugs, cones, washers to act as spreader within form, nor leave a hole larger than 20 mm (3/4 inch) diameter, or a depression in exposed concrete surface, or leave metal closer than 40 mm (1 1/2 inches) to concrete surface. Wire ties not permitted. Cutting ties back from concrete face not permitted.

2.2 MATERIALS:

- A. Portland Cement: ASTM C150 Type I or II.
- B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalies, and loss on ignition (LOI) not to exceed 5 percent.
- C. Coarse Aggregate: ASTM C33.
 - 1. Size 67 or Size 467 may be used for footings and walls over 300 mm (12 inches) thick.
 - 2. Coarse aggregate for applied topping, encasement of steel columns, and metal pan stair fill shall be Size 7.
 - 3. Maximum size of coarse aggregates not more than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourth of minimum clear spacing between reinforcing bars.
- D. Lightweight Aggregates for Structural Concrete: ASTM C330, Table 1. Maximum size of aggregate not larger than one-fifth of narrowest dimension between forms, nor three-fourth of minimum clear distance between reinforcing bars. Contractor to furnish certified report to verify that aggregate is sound and durable, and has a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666.
- E. Fine Aggregate: ASTM C33. Fine aggregate for applied concrete floor topping shall pass a 4.75 mm (No. 4) sieve, 10 percent maximum shall pass a 150 µm (No. 100) sieve.
- F. Mixing Water: Fresh, clean, and potable.
- G. Admixtures:

1. Water Reducing Admixture: ASTM C494, Type A and not contain more chloride ions than are present in municipal drinking water.
 2. Water Reducing, Retarding Admixture: ASTM C494, Type D and not contain more chloride ions than are present in municipal drinking water.
 3. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or G, and not contain more chloride ions than are present in municipal drinking water.
 4. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. Admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory of at least one year duration using an acceptable accelerated corrosion test method such as that using electrical potential measures.
 5. Air Entraining Admixture: ASTM C260.
 6. Prohibited Admixtures: Calcium chloride, thiocyanate or admixtures containing more than 0.05 percent chloride ions are not permitted.
 7. Certification: Test Report for Concrete Mix Designs shall include written conformance to the requirements above, to the requirements regarding chloride ion content of the admixtures, and to the compatibility of all admixtures used in a mix.
- H. Vapor Barrier: ASTM D4397, 0.25 mm (10 mil).
- I. Reinforcing Steel: ASTM A615, deformed, grade as shown.
- J. Reinforcing Bars to be Welded or where indicated on the Drawings: ASTM A706, deformed, grade as shown.
- K. Supports, Spacers, and Chairs: Types which will hold reinforcement in position shown in accordance with requirements of ACI 318 except as specified.
- L. Expansion Joint Filler: ASTM D1751.
- M. Sheet Materials for Curing Concrete: ASTM C171.
- N. Liquid Membrane-forming Compounds for Curing Concrete: ASTM C309, Type I, with fugitive dye. Compound shall be compatible with scheduled surface treatment, such as paint and resilient tile, and shall not discolor concrete surface.
- O. Moisture Vapor Emissions & Alkalinity Control Sealer: 100% active colorless aqueous silicate solution concrete surface treatment applied the day of the concrete pour in lieu of other curing methods for all concrete slabs receiving resilient flooring, such as, sheet vinyl, vinyl composition tile, rubber, wood flooring, carpet, epoxy coatings and overlays .

1. ASTM C1315 Type 1 Class A, and ASTM C309 Type 1 Class A, penetrating product to have no less than 34% solid content, leaving no sheen, volatile organic compound (VOC) content rating as required to suite regulatory requirements. The product shall have at least a five (5) year documented history in controlling moisture vapor emission from damaging floor covering, compatible with all finish materials.
2. MVE 15-Year Warranty:
 - a. When a floor covering is installed on a below grade, on grade, or above grade concrete slab treated with Moisture Vapor Emissions & Alkalinity Control Sealer according to manufacturer's instruction, sealer manufacturer shall warrant the floor covering system against failure due to moisture vapor migration or moisture-born contaminates for a period of fifteen (15) years from the date of original installation. The warranty shall cover all labor and materials needed to replace all floor covering that fails due to moisture vapor emission & moisture born contaminates.

P. Non-Shrink Grout:

1. For Installation at Column Base Plates,
ASTM C1107, pre-mixed, non-metallic, produce a compressive strength of at least 31 MPa (4,500 psi) at three days and 52 MPa (7,500 psi) at 28 days. Furnish test data from an independent laboratory indicating that the grout when placed at the consistency associated with the specified strength shall achieve 95 percent bearing under a 900 mm x 900 mm (3 foot by 3 foot) base plate.
2. For applications other than at base plates,
ASTM C1107, pre-mixed, non-metallic, produce compressive strength of at least 31 MPa (4,500 psi) at three days and 52 MPa (7500 psi) at 28 days.

Q. Adhesive Binder: ASTM C881.

1. Porous Backfill: Crushed stone or gravel graded from 25 mm to 20 mm (1 inch to 3/4 inch).
2. Synthetic Fibers: 100 percent virgin homopolymer polypropylene fibrillated fibers for secondary reinforcing of concrete members. Use appropriate length and minimum dosage rate of 1.2 kg/m³ (2.0 lb. per cubic yard). Product shall have a UL rating.
3. Steel Fibers: ASTM A820, Type I cold drawn, high tensile steel wire for use as primary reinforcing in slab-on-grade. Minimum dosage rate 18 kg/m³ (30 lb. per cubic yard).
4. Blended Fibers: Blend of Synthetic Fibers and Steel Fibers.
5. Epoxy Joint Filler: Two component, 100 percent solids compound, with a minimum shore D hardness of 50.

6. Bonding Admixture: Non-rewettable, polymer modified, bonding compound.
7. Architectural Concrete: For areas designated as architectural concrete on the Contract Documents, use colored cements and specially selected aggregates as necessary to produce a concrete of a color and finish which exactly matches the designated sample panel.

2.3 CONCRETE MIXES:

- A. Mix Designs: Proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318.
 1. If trial mixes are used, make a set of at least 6 cylinders in accordance with ASTM C192 for test purposes from each trial mix; test three for compressive strength at 7 days and three at 28 days.
 2. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, fly ash, admixtures, weight of fine and coarse aggregate per m³ (cubic yard) measured dry rodded and damp loose, specific gravity, fineness modulus, percentage of moisture, air content, water-cement-fly ash ratio, and consistency of each cylinder in terms of slump. Include dry unit weight of lightweight structural concrete.
 3. Prepare a curve showing relationship between water-cement-fly ash ratio at 7-day and 28-day compressive strengths. Plot each curve using at least three specimens.
 4. If the field experience method is used, submit complete standard deviation analysis.
- B. Fly Ash Testing: Submit certificate verifying conformance with specifications initially with mix design and for each truck load of fly ash delivered from source. Notify Resident Engineer immediately when change in source is anticipated. Prior to beginning trial mixes submit to the Resident Engineer the following representative samples of material to be used, properly identified source and project description and number, type of testing (complete chemical and physical), suitably packaged for shipment, and addressed as specified. Allow 60 calendar days for test results after submittal of sample.
 1. Fly ash - 2.25 kg (five pounds).
 2. Portland cement - 3.5 kg (8 pounds):
 - a. Address -Waterways Experiment Station (WES)
 - b. 3909 Halls Ferry Road
 - c. Vicksburg, MS 39180-6199
 - d. ATTN: Engineering Materials Group
- C. After approval of mixes no substitution in material or change in proportions of approval mixes may be made without additional tests and

approval of Resident Engineer or as specified. Making and testing of preliminary test cylinders may be carried on pending approval of cement and fly ash, providing Contractor and manufacturer certify that ingredients used in making test cylinders are the same. Resident Engineer may allow Contractor to proceed with depositing concrete for certain portions of work, pending final approval of cement and fly ash and approval of design mix.

- D. Cement Factor: Maintain minimum cement factors in Table I regardless of compressive strength developed above minimums. In mix designs where fly ash is utilized, use as an admixture with 20% replacement by weight in all structural work.

TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE

Concrete Strength		Non-Air-Entrained	Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement kg/m ³ (lbs/c. yd)	Max. Water Cement Ratio	Min. Cement kg/m ³ (lbs/c. yd)	Max. Water Cement Ratio
35 (5000) ^{1,3}	375 (630)	0.45	385 (650)	0.40
30 (4000) ^{1,3}	325 (550)	0.55	340 (570)	0.48
25 (3000) ^{1,3}	280 (470)	0.65	290 (490)	0.52
25 (3000) ^{1,2}	300 (500)	*	310 (520)	*

1. If trial mixes are used, the proposed mix design shall achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. For concrete strengths above 35 Mpa (5000 psi), the proposed mix design shall achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.
 2. Lightweight Structural Concrete. Pump mixes may require higher cement values.
 3. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.
 4. Determined by Laboratory in accordance with ACI 211.1 for normal concrete or ACI 211.2 for lightweight structural concrete.
- E. Maximum Slump: Maximum slump, as determined by ASTM C143 with tolerances as established by ASTM C94, for concrete to be vibrated shall be as shown in Table II.

TABLE II - MAXIMUM SLUMP, MM (INCHES)*

Type of Construction	Normal Weight Concrete	Lightweight Structural Concrete
Reinforced Footings and Substructure Walls	75mm (3 inches)	75 mm (3 inches)

Topping over Metal Deck, Slabs, Beams, Reinforced Walls, and Building Columns	100 mm (4 inches)	100 mm (4 inches)
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- F. Slump may be increased by the use of the approved high-range water-reducing admixture (superplasticizer). Tolerances as established by ASTM C94. Concrete containing the high-range-water-reducing admixture may have a maximum slump of 225 mm (9 inches). The concrete shall arrive at the job site at a slump of 50 mm to 75 mm (2 inches to 3 inches), and 75 mm to 100 mm (3 inches to 4 inches) for lightweight concrete. This should be verified, and then the high-range-water-reducing admixture added to increase the slump to the approved level.
- G. Air-Entrainment: Air-entrainment of normal weight concrete shall conform with Table III. Air-entrainment of lightweight structural concrete shall conform with Table IV. Determine air content by either ASTM C173 or ASTM C231.

**TABLE III - TOTAL AIR CONTENT
FOR VARIOUS SIZES OF COARSE AGGREGATES (NORMAL CONCRETE)**

Nominal Maximum Size of Coarse Aggregate, mm (inches)	Total Air Content Percentage by Volume
20 mm (3/4 in)	4 to 7%
25 mm (1 in)	3-1/2 to 6-1/2%
40 mm (1-1/2 in)	3 to 6 percent

**TABLE IV
AIR CONTENT OF LIGHTWEIGHT STRUCTURAL CONCRETE**

Nominal Maximum Size of Coarse Aggregate, mm (inches)	Total Air Content Percentage by Volume
10 mm (3/8 in)	5 to 8%
Greater than 10 mm (3/8 in)	4 to 7%

- H. High early strength concrete, made with Type III cement or Type I cement plus non-corrosive accelerator, shall have a 7-day compressive strength equal to specified minimum 28-day compressive strength for concrete type specified made with standard Portland cement.
- I. Lightweight structural concrete shall not weigh more than air-dry unit weight of 1840 kg/m³ (115 pcf). Air-dry unit weight determined on 150 mm by 300 mm (6 inch by 12 inch) test cylinders after seven days standard moist curing followed by 21 days drying at 23 degrees C \pm 1.7 degrees C (73.4 \pm 3 degrees Fahrenheit), and 50 (plus or minus 7) percent relative

humidity. Use wet unit weight of fresh concrete as basis of control in field.

- J. Concrete slabs placed at air temperatures below 10 degrees C (50 degrees Fahrenheit) use non-corrosive, non-chloride accelerator. Concrete required to be air entrained use approved air entraining admixture. Pumped concrete, synthetic or blended fiber reinforced concrete, architectural concrete, concrete required to be watertight, and concrete with a water/cement ratio below 0.50 use high-range water-reducing admixture (superplasticizer).
- K. Durability: Use air entrainment for building slabs on grade, concrete topping over metal deck, all exterior exposed concrete subjected to freezing and thawing and other concrete shown or specified. Air content as shown in Table III or Table IV.
- L. Enforcing Strength Requirements: Test as specified in Section 01 45 29, TESTING LABORATORY SERVICES, during the progress of the work. Seven-day tests may be used as indicators of 28-day strength. Average of any three 28-day consecutive strength tests of laboratory-cured specimens representing each type of concrete shall be equal to or greater than specified strength. No single test shall be more than 3.5 MPa (500 psi) below specified strength. Interpret field test results in accordance with ACI 214. Should strengths shown by test specimens fall below required values, Resident Engineer may require any one or any combination of the following corrective actions, at no additional cost to the Government:
 - 1. Require changes in mix proportions by selecting one of the other appropriate trial mixes or changing proportions, including cement content, of approved trial mix.
 - 2. Require additional curing and protection.
 - 3. If five consecutive tests fall below 95 percent of minimum values given in Table I or if test results are so low as to raise a question as to the safety of the structure, Resident Engineer may direct Contractor to take cores from portions of the structure. Use results from cores tested by the Contractor retained testing agency to analyze structure.
 - 4. If strength of core drilled specimens falls below 85 percent of minimum value given in Table I, Resident Engineer may order load tests, made by Contractor retained testing agency, on portions of building so affected. Load tests in accordance with ACI 318 and criteria of acceptability of concrete under test as given therein.

5. Concrete work, judged inadequate by structural analysis, by results of load test, or for any reason, shall be reinforced with additional construction or replaced, if directed by the Resident Engineer.

2.4 BATCHING AND MIXING:

- A. General: Concrete shall be "Ready-Mixed" and comply with ACI 318 and ASTM C94, except as specified. Batch mixing at the site is permitted. Mixing process and equipment must be approved by Resident Engineer. With each batch of concrete, furnish certified delivery tickets listing information in Paragraph 16.1 and 16.2 of ASTM C94. Maximum delivery temperature of concrete is 38°C (100 degrees Fahrenheit). Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
-1.0 degrees to 4.4 degrees C (30 degrees to 40 degrees F)	15.6 degrees C (60 degrees F.)
-17 degrees C to -1.1 degrees C (0 degrees to 30 degrees F.)	21 degrees C (70 degrees F.)

1. Services of aggregate manufacturer's representative shall be furnished during the design of trial mixes and as requested by the Resident Engineer for consultation during batching, mixing, and placing operations of lightweight structural concrete. Services will be required until field controls indicate that concrete of required quality is being furnished. Representative shall be thoroughly familiar with the structural lightweight aggregate, adjustment and control of mixes to produce concrete of required quality. Representative shall assist and advise Resident Engineer.

PART 3 - EXECUTION

3.1 FORMWORK:

- A. General: Design in accordance with ACI 347 is the responsibility of the Contractor. The Contractor shall retain a registered Professional Engineer to design the formwork and shores where concrete placement height exceeds five feet.
- Form boards and plywood forms may be reused for contact surfaces of exposed concrete only if thoroughly cleaned, patched, and repaired and Resident Engineer approves their reuse.
 - Provide forms for concrete footings unless Resident Engineer determines forms are not necessary.
 - Corrugated fiberboard forms: Place forms on a smooth firm bed, set tight, with no buckled cartons to prevent horizontal displacement, and in a dry condition when concrete is placed.

- B. Treating and Wetting: Treat or wet contact forms as follows:
1. Coat plywood and board forms with non-staining form sealer. In hot weather, cool forms by wetting with cool water just before concrete is placed.
 2. Clean and coat removable metal forms with light form oil before reinforcement is placed. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.
 3. Use sealer on reused plywood forms as specified for new material.
- C. Size and Spacing of Studs: Size and space studs, wales and other framing members for wall forms so as not to exceed safe working stress of kind of lumber used nor to develop deflection greater than $1/270$ of free span of member.
- D. Unlined Forms: Use plywood forms to obtain a smooth finish for concrete surfaces. Tightly butt edges of sheets to prevent leakage. Back up all vertical joints solidly and nail edges of adjacent sheets to same stud with 6d box nails spaced not over 150 mm (6 inches) apart.
- E. Lined Forms: May be used in lieu of unlined plywood forms. Back up form lining solidly with square edge board lumber securely nailed to studs with all edges in close contact to prevent bulging of lining. No joints in lining and backing may coincide. Nail abutted edges of sheets to same backing board. Nail lining at not over 200 mm (8 inches) on center along edges and with at least one nail to each square foot of surface area; nails to be 3d blued shingle or similar nails with thin flatheads.
- F. Wall Form Ties: Locate wall form ties in symmetrically level horizontal rows at each line of wales and in plumb vertical tiers. Space ties to maintain true, plumb surfaces. Provide one row of ties within 150 mm (6 inches) above each construction joint. Space through-ties adjacent to horizontal and vertical construction joints not over 450 mm (18 inches) on center.
1. Tighten row of ties at bottom of form just before placing concrete and, if necessary, during placing of concrete to prevent seepage of concrete and to obtain a clean line. Ties to be entirely removed shall be loosened 24 hours after concrete is placed and shall be pulled from least important face when removed.
 2. Coat surfaces of all metal that is to be removed with paraffin, cup grease or a suitable compound to facilitate removal.
- G. Inserts, Sleeves, and Similar Items: Flashing reglets, steel strips, masonry ties, anchors, wood blocks, nailing strips, grounds, inserts, wire hangers, sleeves, drains, guard angles, forms for floor hinge boxes, inserts or bond blocks for elevator guide rails and supports, and other items specified as furnished under this and other sections of

specifications and required to be in their final position at time concrete is placed shall be properly located, accurately positioned, and built into construction, and maintained securely in place.

1. Install sleeves, inserts and similar items for mechanical services in accordance with drawings prepared specially for mechanical services. Contractor is responsible for accuracy and completeness of drawings and shall coordinate requirements for mechanical services and equipment.
2. Minimum clear distance of embedded items such as conduit and pipe is at least three times diameter of conduit or pipe, except at stub-ups and other similar locations.
3. Provide recesses and blockouts in floor slabs for door closers and other hardware as necessary in accordance with manufacturer's instructions.

H. Construction Tolerances:

1. Set and maintain concrete formwork to assure erection of completed work within tolerances specified and to accommodate installation of other rough and finish materials. Accomplish remedial work necessary for correcting excessive tolerances. Erected work that exceeds specified tolerance limits shall be remedied or removed and replaced, at no additional cost to the Government.
2. Permissible surface irregularities for various classes of materials are defined as "finishes" in specification sections covering individual materials. They are to be distinguished from tolerances specified which are applicable to surface irregularities of structural elements.

3.2 PLACING REINFORCEMENT:

- A. General: Details of concrete reinforcement in accordance with ACI 318 unless otherwise shown.
- B. Placing: Place reinforcement conforming to CRSI DA4, unless otherwise shown.
 1. Place reinforcing bars accurately and tie securely at intersections and splices with 1.6 mm (16 gauge) black annealed wire. Secure reinforcing bars against displacement during the placing of concrete by spacers, chairs, or other similar supports. Portions of supports, spacers, and chairs in contact with formwork shall be made of plastic in areas that will be exposed when building is occupied. Type, number, and spacing of supports conform to ACI 318. Where concrete slabs are placed on ground, use concrete blocks or other non-corrodible material of proper height, for support of reinforcement. Use of brick or stone supports will not be permitted.

- C. Spacing: Minimum clear distances between parallel bars, except in multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 25 mm (1 inch) or 1-1/3 times maximum size of coarse aggregate.
- D. Splicing: Splices of reinforcement made only as required or shown or specified. Accomplish splicing as follows:
 - 1. Lap splices: Do not use lap splices for bars larger than Number 36 (Number 11). Minimum lengths of lap as shown.
 - 2. Welded splices: Splicing by butt-welding of reinforcement permitted providing the weld develops in tension at least 125 percent of the yield strength (fy) for the bars. Welding conform to the requirements of AWS D1.4. Welded reinforcing steel conform to the chemical analysis requirements of AWS D1.4.
 - a. Submit test reports indicating the chemical analysis to establish weldability of reinforcing steel.
 - b. Submit a field quality control procedure to insure proper inspection, materials and welding procedure for welded splices.
 - c. Department of Veterans Affairs retained testing agency shall test a minimum of three splices, for compliance, locations selected by Resident Engineer.
 - 3. Mechanical Splices: Develop in tension and compression at least 125 percent of the yield strength (fy) of the bars. Stresses of transition splices between two reinforcing bar sizes based on area of smaller bar. Provide mechanical splices at locations indicated. Use approved exothermic, tapered threaded coupling, or swaged and threaded sleeve. Exposed threads and swaging in the field not permitted.
 - a. Initial qualification: In the presence of Resident Engineer, make three test mechanical splices of each bar size proposed to be spliced. Department of Veterans Affairs retained testing laboratory will perform load test.
 - b. During installation: Furnish, at no additional cost to the Government, one companion (sister) splice for every 50 splices for load testing. Department of Veterans Affairs retained testing laboratory will perform the load test.
- E. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by Resident Engineer.
- F. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce bond.

- G. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise shown.

3.3 VAPOR BARRIER:

- A. Except where membrane waterproofing is required, interior concrete slab on grade shall be placed on a continuous vapor barrier.
1. Vapor barrier shall be placed over 100 mm (4 inches) of granular fill.
 2. Vapor barrier joints lapped 150 mm (6 inches) and sealed with compatible waterproof pressure-sensitive tape.
 3. Patch punctures and tears prior to placing concrete.

3.4 MOISTURE VAPOR EMISSIONS & ALKALINITY CONTROL SEALER:

- A. Sealer is applied on the day of the concrete pour or as as soon as harsh weather permits, prior to any other chemical treatments for concrete slabs either on grade, below grade or above grade receiving resilient flooring, such as, sheet vinyl, vinyl composition tile, rubber, wood flooring, carpet, epoxy coatings and overlays.
- B. Manufacturer's representative will be on the site the day of concrete pour to install or train its application and document. He shall return on every application thereafter to verify that proper procedures are followed.
1. Apply Sealer to concrete slabs as soon as final finishing operations are complete and the concrete has hardened sufficiently to sustain floor traffic without damage.
 2. Spray apply Sealer at the rate of 20 m² (200 square feet) per gallon. Lightly broom product evenly over the substrate and product has completely penetrated the surface.
 3. If within two (2) hours after initial application areas are subjected to heavy rainfall and puddling occurs, reapply Sealer product to these areas as soon as weather condition permits.

3.5 CONSTRUCTION JOINTS:

- A. Unless otherwise shown, location of construction joints to limit individual placement shall not exceed 18,000 mm (60 feet) in any horizontal direction, except slabs on grade which shall have construction joints shown. Allow 48 hours to elapse between pouring adjacent sections unless this requirement is waived by Resident Engineer.

3.6 EXPANSION JOINTS:

- A. Clean expansion joint surfaces before installing premolded filler and placing adjacent concrete.

3.7 PLACING CONCRETE:

A. Preparation:

1. Remove hardened concrete, wood chips, shavings and other debris from forms.
2. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
3. Have forms and reinforcement inspected and approved by Resident Engineer before depositing concrete.
4. Provide runways for wheeling equipment to convey concrete to point of deposit. Keep equipment on runways which are not supported by or bear on reinforcement. Provide similar runways for protection of vapor barrier on coarse fill.

B. Bonding: Before depositing new concrete on or against concrete which has been set, thoroughly roughen and clean existing surfaces of laitance, foreign matter, and loose particles.

1. Preparing surface for applied topping:

- a. Remove laitance, mortar, oil, grease, paint, or other foreign material by sand blasting. Clean with vacuum type equipment to remove sand and other loose material.
- b. Broom clean and keep base slab wet for at least four hours before topping is applied.
- c. Use a thin coat of one part Portland cement, 1.5 parts fine sand, bonding admixture; and water at a 50: 50 ratio and mix to achieve the consistency of thick paint. Apply to a damp base slab by scrubbing with a stiff fiber brush. New concrete shall be placed while the bonding grout is still tacky.

C. Conveying Concrete: Convey concrete from mixer to final place of deposit by a method which will prevent segregation. Method of conveying concrete subject to approval of Resident Engineer.

D. Placing: For special requirements see Paragraphs, HOT WEATHER and COLD WEATHER.

1. Do not place concrete when weather conditions prevent proper placement and consolidation, or when concrete has attained its initial set, or has contained its water or cement content more than 1 1/2 hours.
2. Deposit concrete in forms as near as practicable in its final position. Prevent splashing of forms or reinforcement with concrete in advance of placing concrete.
3. Do not drop concrete freely more than 3000 mm (10 feet) for concrete containing the high-range water-reducing admixture (superplasticizer) or 1500 mm (5 feet) for conventional concrete. Where greater drops

are required, use a tremie or flexible spout (canvas elephant trunk), attached to a suitable hopper.

4. Discharge contents of tremies or flexible spouts in horizontal layers not exceeding 500 mm (20 inches) in thickness, and space tremies such as to provide a minimum of lateral movement of concrete.
5. Continuously place concrete until an entire unit between construction joints is placed. Rate and method of placing concrete shall be such that no concrete between construction joints will be deposited upon or against partly set concrete, after it's initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
6. On bottom of members with severe congestion of reinforcement, deposit 25 mm (1 inch) layer of flowing concrete containing the specified high-range water-reducing admixture (superplasticizer). Successive concrete lifts may be a continuation of this concrete or concrete with a conventional slump.
7. Concrete on metal deck:
 - a. Concrete on metal deck shall be minimum thickness shown. Allow for deflection of steel beams and metal deck under the weight of wet concrete in calculating concrete quantities for slab.
 - 1) The Contractor shall become familiar with deflection characteristics of structural frame to include proper amount of additional concrete due to beam/deck deflection.
- E. Consolidation: Conform to ACI 309. Immediately after depositing, spade concrete next to forms, work around reinforcement and into angles of forms, tamp lightly by hand, and compact with mechanical vibrator applied directly into concrete at approximately 450 mm (18 inch) intervals. Mechanical vibrator shall be power driven, hand operated type with minimum frequency of 5000 cycles per minute having an intensity sufficient to cause flow or settlement of concrete into place. Vibrate concrete to produce thorough compaction, complete embedment of reinforcement and concrete of uniform and maximum density without segregation of mix. Do not transport concrete in forms by vibration.
 1. Use of form vibration shall be approved only when concrete sections are too thin or too inaccessible for use of internal vibration.
 2. Carry on vibration continuously with placing of concrete. Do not insert vibrator into concrete that has begun to set.

3.8 HOT WEATHER:

Follow the recommendations of ACI 305 or as specified to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete. Methods proposed for cooling materials and arrangements for

protecting concrete shall be made in advance of concrete placement and approved by Resident Engineer.

3.9 COLD WEATHER:

Follow the recommendations of ACI 306 or as specified to prevent freezing of concrete and to permit concrete to gain strength properly. Use only the specified non-corrosive, non-chloride accelerator. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions. Methods proposed for heating materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by Resident Engineer.

3.10 PROTECTION AND CURING:

- A. Conform to ACI 308: Initial curing shall immediately follow the finishing operation. Protect exposed surfaces of concrete from premature drying, wash by rain and running water, wind, mechanical injury, and excessively hot or cold temperatures. Keep concrete slabs not covered with membrane or other curing material continuously wet for at least 7 days after placing, except wet curing period for high-early-strength concrete shall be not less than 3 days. Keep wood forms continuously wet to prevent moisture loss until forms are removed. Cure exposed concrete surfaces as described below. Other curing methods may be used if approved by Resident Engineer.

- 1. Liquid curing and sealing compounds: Apply by power-driven spray or roller in accordance with the manufacturer's instructions. Apply immediately after finishing. Maximum coverage 10m²/L (400 square feet per gallon) on steel troweled surfaces and 7.5m²/L (300 square feet per gallon) on floated or broomed surfaces for the curing/sealing compound.
- 2. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with tape.

3.11 REMOVAL OF FORMS:

- A. Remove in a manner to assure complete safety of structure after the following conditions have been met.
- 1. Where structure as a whole is supported on shores, forms for beams and girder sides, columns, and similar vertical structural members may be removed after 24 hours, provided concrete has hardened sufficiently to prevent surface damage and curing is continued without any lapse in time as specified for exposed surfaces.

2. Take particular care in removing forms of architectural exposed concrete to insure surfaces are not marred or gouged, and that corners and arises are true, sharp and unbroken.
- B. Control Test: Use to determine if the concrete has attained sufficient strength and curing to permit removal of supporting forms. Cylinders required for control tests taken in accordance with ASTM C172, molded in accordance with ASTM C31, and tested in accordance with ASTM C39. Control cylinders cured and protected in the same manner as the structure they represent. Supporting forms or shoring not removed until strength of control test cylinders have attained at least 70 percent of minimum 28-day compressive strength specified. Exercise care to assure that newly unsupported portions of structure are not subjected to heavy construction or material loading.
- C. Reshoring: Reshoring is required if superimposed load plus dead load of the floor exceeds the capacity of the floor at the time of loading. Reshoring accomplished in accordance with ACI 347 at no additional cost to the Government.

3.12 CONCRETE SURFACE PREPARATION:

- A. Metal Removal: Unnecessary metal items cut back flush with face of concrete members.
- B. Patching: Maintain curing and start patching as soon as forms are removed. Do not apply curing compounds to concrete surfaces requiring patching until patching is completed. Use cement mortar for patching of same composition as that used in concrete. Use white or gray Portland cement as necessary to obtain finish color matching surrounding concrete. Thoroughly clean areas to be patched. Cut out honeycombed or otherwise defective areas to solid concrete to a depth of not less than 25 mm (1 inch). Cut edge perpendicular to surface of concrete. Saturate with water area to be patched, and at least 150 mm (6 inches) surrounding before placing patching mortar. Give area to be patched a brush coat of cement grout followed immediately by patching mortar. Cement grout composed of one part Portland cement, 1.5 parts fine sand, bonding admixture, and water at a 50:50 ratio, mix to achieve consistency of thick paint. Mix patching mortar approximately 1 hour before placing and remix occasionally during this period without addition of water. Compact mortar into place and screed slightly higher than surrounding surface. After initial shrinkage has occurred, finish to match color and texture of adjoining surfaces. Cure patches as specified for other concrete. Fill form tie holes which extend entirely through walls from unexposed face by means of a pressure gun or other

suitable device to force mortar through wall. Wipe excess mortar off exposed face with a cloth.

- C. Upon removal of forms, clean vertical concrete surface that is to receive bonded applied cementitious application with wire brushes or by sand blasting to remove unset material, laitance, and loose particles to expose aggregates to provide a clean, firm, granular surface for bond of applied finish.

3.13 CONCRETE FINISHES:

A. Vertical and Overhead Surface Finishes:

1. Unfinished areas: Vertical and overhead concrete surfaces exposed in pipe basements, elevator and dumbwaiter shafts, pipe spaces, pipe trenches, above suspended ceilings, manholes, and other unfinished areas will not require additional finishing.
2. Interior and exterior exposed areas to be painted: Remove fins, burrs and similar projections on surfaces flush, and smooth by mechanical means approved by Resident Engineer, and by rubbing lightly with a fine abrasive stone or hone. Use ample water during rubbing without working up a lather of mortar or changing texture of concrete.
3. Interior and exterior exposed areas finished: Give a grout finish of uniform color and smooth finish treated as follows:
 - a. After concrete has hardened and laitance, fins and burrs removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone stone.
 - b. Apply grout composed of one part of Portland cement, one part fine sand, smaller than a 600 μ m (No. 30) sieve. Work grout into surface of concrete with cork floats or fiber brushes until all pits, and honeycombs are filled.
 - c. After grout has hardened slightly, but while still plastic, scrape grout off with a sponge rubber float and, about 1 hour later, rub concrete vigorously with burlap to remove any excess grout remaining on surfaces.
 - d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish of area in same day. Make limits of finished areas at natural breaks in wall surface. Leave no grout on concrete surface overnight.

B. Slab Finishes:

1. Monitoring and Adjustment: Provide continuous cycle of placement, measurement, evaluation and adjustment of procedures to produce slabs within specified tolerances. Monitor elevations of structural steel in key locations before and after concrete placement to establish typical deflection patterns for the structural steel. Determine

elevations of cast-in-place slab soffits prior to removal of shores. Provide information to Resident Engineer and floor consultant for evaluation and recommendations for subsequent placements.

2. Set perimeter forms to serve as screed using either optical or laser instruments. For slabs on grade, wet screeds may be used to establish initial grade during strike-off, unless Resident Engineer determines that the method is proving insufficient to meet required finish tolerances and directs use of rigid screed guides. Where wet screeds are allowed, they shall be placed using grade stakes set by optical or laser instruments. Use rigid screed guides, as opposed to wet screeds, to control strike-off elevation for all types of elevated (non slab-on-grade) slabs. Divide bays into halves or thirds by hard screeds. Adjust as necessary where monitoring of previous placements indicates unshored structural steel deflections to other than a level profile.
3. Place slabs within perimeter forms monolithically. Once slab placement commences, complete finishing operations within same day. Slope finished slab to floor drains where they occur, whether shown or not.
4. Use straightedges specifically made for screeding, such as hollow magnesium straightedges or power strike-offs. Do not use pieces of dimension lumber. Strike off and screed slab to a true surface at required elevations. Use optical or laser instruments to check concrete finished surface grade after strike-off. Repeat strike-off as necessary. Complete screeding before any excess moisture or bleeding water is present on surface. Do not sprinkle dry cement on the surface.
5. Immediately following screeding, and before any bleed water appears, use a 3000 mm (10 foot) wide highway straightedge in a cutting and filling operation to achieve surface flatness. Do not use bull floats or darbys, except that darbying may be allowed for narrow slabs and restricted spaces.
6. Wait until water sheen disappears and surface stiffens before proceeding further. Do not perform subsequent operations until concrete will sustain foot pressure with maximum of 6 mm (1/4 inch) indentation.
7. Scratch Finish: Finish base slab to receive a bonded applied cementitious application as indicated above, except that bull floats and darbys may be used. Thoroughly coarse wire broom within two hours after placing to roughen slab surface to insure a permanent bond between base slab and applied materials.

8. Float Finish: Slabs to receive unbonded toppings, steel trowel finish, fill, mortar setting beds, or a built-up roof, and ramps, stair treads, platforms (interior and exterior), and equipment pads shall be floated to a smooth, dense uniform, sandy textured finish. During floating, while surface is still soft, check surface for flatness using a 3000 mm (10 foot) highway straightedge. Correct high spots by cutting down and correct low spots by filling in with material of same composition as floor finish. Remove any surface projections and re-float to a uniform texture.
9. Steel Trowel Finish: Concrete surfaces to receive resilient floor covering or carpet, monolithic floor slabs to be exposed to view in finished work, future floor roof slabs, applied toppings, and other interior surfaces for which no other finish is indicated. Steel trowel immediately following floating. During final troweling, tilt steel trowel at a slight angle and exert heavy pressure to compact cement paste and form a dense, smooth surface. Finished surface shall be smooth, free of trowel marks, and uniform in texture and appearance.
10. Broom Finish: Finish exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after surfaces have been floated. Brush in a direction transverse to main traffic. Match texture approved by Resident Engineer from sample panel.
11. Finished slab flatness (FF) and levelness (FL) values comply with the following minimum requirements:
 - a. Areas covered with carpeting, or not specified otherwise in b. below:
 - 1) Slab on Grade:
 - a) Specified overall value F_F 25/F_L 20
 - b) Minimum local value F_F 17/F_L 15
 - 2) Level elevated slabs and metal deck with concrete topping slabs:
 - a) Specified overall value FF 25/FL 20
 - b) Minimum local value FF 17/FL 15
 - 3) Level tolerance such that 80 percent of all points fall within a 20 mm (3/4 inch) envelope +10 mm, -10 mm (+3/8 inch, -3/8 inch) from the design elevation.
 - b. Areas that will be exposed, receive thin-set tile or resilient flooring, or roof areas designed as future floors:
 - 1) Slab on grade:
 - a) Specified overall value FF 36/FL 20
 - b) Minimum local value FF 24/FL 15

- 2) Level elevated slabs and metal deck with concrete topping slabs
 - a) Specified overall value FF 30/FL 20
 - b) Minimum local value FF 24/FL 15
 - 3) Level tolerance such that 80 percent of all points fall within a 20 mm (3/4 inch) envelope +10 mm, -10 mm (+3/8 inch, -3/8 inch) from the design elevation.
 - c. "Specified overall value" is based on the composite of all measured values in a placement derived in accordance with ASTM E1155.
 - d. "Minimum local value" (MLV) describes the flatness or levelness below which repair or replacement is required. MLV is based on the results of an individual placement and applies to a minimum local area. Minimum local area boundaries may not cross a construction joint or expansion joint. A minimum local area will be bounded by construction and/or control joints, or by column lines and/or half-column lines, whichever is smaller.
12. Measurements
- a. Department of Veterans Affairs retained testing laboratory will take measurements as directed by Resident Engineer, to verify compliance with FF, FL, and other finish requirements. Measurements will occur within 72 hours after completion of concrete placement (weekends and holidays excluded). Make measurements before shores or forms are removed to ensure the "as-built" levelness is accurately assessed. Profile data for above characteristics may be collected using a laser level or any Type II apparatus (ASTM E1155, "profileograph" or "dipstick"). Contractor's surveyor shall establish reference elevations to be used by Department of Veterans Affairs retained testing laboratory.
 - b. Contractor not experienced in using FF and FL criteria is encouraged to retain the services of a floor consultant to assist with recommendations concerning adjustments to slab thicknesses, finishing techniques, and procedures on measurements of the finish as it progresses in order to achieve the specific flatness and levelness numbers.
13. Acceptance/ Rejection:
- a. If individual slab section measures less than either of specified minimum local F_F/F_L numbers, that section shall be rejected and remedial measures shall be required. Sectional boundaries may be set at construction and contraction (control) joints, and not smaller than one-half bay.

- b. If composite value of entire slab installation, combination of all local results, measures less than either of specified overall F_F/F_L numbers, then whole slab shall be rejected and remedial measures shall be required.
- 14. Remedial Measures for Rejected Slabs: Correct rejected slab areas by grinding, planing, surface repair with underlayment compound or repair topping, retopping, or removal and replacement of entire rejected slab areas, as directed by Resident Engineer, until a slab finish constructed within specified tolerances is accepted.

3.14 SURFACE TREATMENTS:

- A. Use on exposed concrete floors and concrete floors to receive carpeting.
- B. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms. Broadcast aggregate uniformly over concrete surface at rate of application of 8% per 1/10th m^2 (7.5 percent per square foot) of area. Trowel concrete surface to smooth dense finish. After curing, rub treated surface with abrasive brick and water to slightly expose abrasive aggregate.

3.15 RESURFACING FLOORS:

Remove existing flooring areas to receive resurfacing to expose existing structural slab and extend not less than 25 mm (1 inch) below new finished floor level. Prepare exposed structural slab surface by roughening, broom cleaning, and dampening. Apply specified bonding grout. Place topping while the bonding grout is still tacky.

3.16 RETAINING WALLS:

- A. Use air-entrained concrete.
- B. Expansion and contraction joints, and reinforcement installed and constructed as shown.
- C. Exposed surfaces finished to match adjacent concrete surfaces, new or existing.
- D. Place porous backfill as shown.

3.17 PRECAST CONCRETE ITEMS:

- A. Precast concrete items, not specified elsewhere. Cast using 25 MPa (3000 psi) air-entrained concrete to shapes and dimensions shown. Finish to match corresponding adjacent concrete surfaces. Reinforce with steel for safe handling and erection.
- B. Precast manufacturer is responsible for design of connections to support precast concrete items from the structure. Connections shall be designed

to support weight of precast units and associated wind and seismic loads.

- - - E N D - - -

**SECTION 03 45 00
PRECAST ARCHITECTURAL CONCRETE**

PART 1 - GENERAL

1.1 DESCRIPTION

This section includes the performance criteria, materials, production, and erection of architectural precast concrete cladding units. The work performed under this section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the architectural precast concrete work shown on the contract drawings.

1.2 RELATED WORK

- A. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- B. Mortar: Section 04 05 13, MASONRY MORTARING
- C. Masonry Facing: Section 04 20 00, UNIT MASONRY.
- D. Cast Stone Facing: Section 04 73 13, CALCIUM SILICATE MANUFACTURED STONE MASONRY.
- E. Sealants and Caulking: Section 07 92 00, JOINT SEALANTS.
- F. Size, type and color of aggregate for exposed aggregate finish and matrix color: Section 09 06 00, SCHEDULE FOR FINISHES.
- G. Repair of abraded galvanized and painted surfaces: Section 09 91 00, PAINTING.

1.3 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that complies with PCI MNL 117 and the following requirements and is experienced in producing units similar to those indicated for this Project and with a record of successful in-service performance:
 - 1. Assumes responsibility for engineering units to comply with performance requirements. A Comprehensive Engineering Analysis shall be performed by a qualified professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated.
 - 2. Participates in PCI's Plant Certification program at the time of bidding and is designated a PCI-certified plant for Group A, Category A1- Architectural Cladding and Load Bearing Units.
 - 3. Has sufficient production capacity to produce required units without delaying the work.
- B. Erector Qualifications:
 - 1. A precast concrete erector Qualified by the Precast/Prestressed Concrete Institute (PCI) prior to beginning work at the project site.

- Submit a current Certificate of Compliance furnished by PCI designating qualification in Category S2 (Complex Structural Systems) for load-bearing members.
2. An erector with a minimum of 5 years of experience who has completed architectural precast concrete work 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.
- C. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117.
- D. Sample Panels/Units: Incorporate full scale details of architectural features, finishes, textures, and transitions in the sample panels.
- E. Mockups: After sample approval but before production of units, construct full sized mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Mockup to be representative of the finished work in all respects, complete with all anchors, connections, flashings, and joint fillers as accepted on the final shop drawings. Build mockups to comply with the following requirements, using materials indicated for the completed work:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Resident Engineer and Architect.
 2. Notify Resident Engineer and Architect in advance of dates and times when mockups will be constructed.
 3. Obtain Resident Engineer's and Architect's approval of mockups before starting fabrication.
 4. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 5. Demolish and remove mockups if so directed.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01, GENERAL REQUIREMENTS.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide units and connections capable of withstanding: the design criteria specified on the drawings, self weights and weights of materials supported or attached, for the conditions indicated.
1. Design Standards: Comply with ACI 318 (ACI 318M) and the design recommendations of PCI MNL 120, applicable to types of units indicated.
 2. Limit deflection of precast members as follows:
 - Vertical live load - $\text{Span} / 360$.
 - Wind load - Floor to floor height times 0.0025.
 3. Design for handling, transportation and erection stresses.

- B. Precast manufacturer is responsible for design of connections to support precast concrete items from the structure. Connections shall be designed to support weight of precast units and associated wind and seismic loads. Design framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live load deflection, shrinkage and creep of primary building structure, and other building movements.
- C. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 49 deg C (120 deg F).

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Retain quality control records and certificates of compliance for 5 years or period of warranty, whichever is greater.
- B. Design Mixes: For each concrete mix along with compressive strength and water-absorption tests.
- C. Shop (Erection) Drawings: Detail fabrication and installation of units.
 - 1. Indicate member locations with distinctive marks that match marks placed on the panels. Provide plans, elevations, dimensions, corner details, shapes, cross sections and relationships to adjacent materials.
 - 2. Indicate aesthetic intent including joints, reveals, and extent and location of each surface finish.
 - 3. Indicate separate face and backup mix locations, and thicknesses.
 - 4. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, and connections.
 - 5. Indicate locations, tolerances and details of anchorage devices to be embedded in or attached to structure or other construction.
 - 6. Indicate sequence of erection.
 - 7. Design Modifications: If design modifications are necessary to meet the performance requirements and field conditions, submit design calculations and drawings. Do not adversely affect the appearance, durability or strength of units when modifying details or materials and maintain the general design concept.
- D. Comprehensive Engineering Analysis: Provide calculations signed and sealed by the qualified professional engineer licensed in the State of Idaho and responsible for the product design. Show governing panel types, connections, and types of reinforcement, including special reinforcement. Indicate design criteria and loads. Indicate the location, type, magnitude and direction of all imposed loadings from the precast system to the building structural frame. //

- E. Samples: Design reference samples for initial verification of design intent, approximately 300 by 300 by 50 mm (12 by 12 by 2 inches), representative of finishes, color, and textures of exposed surfaces of units.
- F. Supply sample showing color and texture of joint treatment.
- G. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Product handling requirements of PCI MNL 117 shall be followed at the plant and project site.
- B. Deliver all units to the project site in such quantities and at such times to assure compliance with the agreed project schedule and proper setting sequence so as to limit unloading units temporarily on the ground.
- C. Lift and support units only at designated points shown on the Shop Drawings.
- D. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

1.7 WARRANTY

- A. Warranty of precast concrete work, including anchorage, joint treatment and related components to be free from defects in materials and workmanship, including cracking and spalling.
- B. After erection, completed work will be weathertight, subject to terms of Article "Warranty of Construction" FAR clause 52.246-21, except warranty period is extended to five years.

1.8 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A27/A27M-03.....Steel Castings, Carbon, for General Application
 - A36/A36M-04.....Carbon Structural Steel
 - A82-02.....Steel Wire, Plain, for Concrete Reinforcement
 - A108-03.....Steel Bar, Carbon and Alloy, Cold-Finished
 - A123/A123M-02.....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - A153/A153M-03.....Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - A185-02.....Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

A283/A283M-03.....Low and Intermediate Tensile Strength Carbon Steel
 Plates
 A307-03.....Carbon Steel Bolts and Studs, 60 000 PSI Tensile
 Strength
 A325/A325M-04.....Structural Bolts, Steel, Heat Treated, 120/105 ksi
 Minimum Tensile Strength
 A490/A490M-04.....Structural Bolts, Alloy Steel, Heat Treated, 150
 ksi Minimum Tensile Strength
 A496-02.....Steel Wire, Deformed, for Concrete Reinforcement
 A497-02.....Steel Welded Wire Reinforcement, Deformed, for
 Concrete
 A563/A563M-04.....Carbon and Alloy Steel Nuts
 A615/A615M-04a.....Deformed and Plain Billet-Steel Bars for Concrete
 Reinforcement
 A675/A675M-03.....Steel Bars, Carbon, Hot-Wrought, Special Quality,
 Mechanical Properties
 A706/A706M-04a.....Low-Alloy Steel Deformed and Plain Bars for
 Concrete Reinforcement
 A767/A767M-00b.....Zinc-Coated (Galvanized) Steel Bars for Concrete
 Reinforcement
 A780-01.....Repair of Damaged and Uncoated Areas of Hot-Dip
 Galvanized Coatings
 C33-03.....Concrete Aggregates
 C40-04.....Organic Impurities in Fine Aggregate for Concrete
 C150-04.....Portland Cement
 C260-01.....Air-Entraining Admixtures for Concrete
 C330-04.....Lightweight Aggregates for Structural Concrete
 C373-88(99).....Test Method for Water Absorption, Bulk Density,
 Apparent Porosity, and Apparent Specific Gravity
 of Fired Whiteware Products
 C494/C494M-01.....Chemical Admixtures for Concrete
 C618-03.....Coal Fly Ash and Raw or Calcined Natural Pozzolan
 for Use as a Mineral Admixture in Concrete
 C989-04.....Ground Granulated Blast-Furnace Slag for Use in
 Concrete and Mortars
 C1017/C1017M-03.....Chemical Admixtures for Use in Producing Flowing
 Concrete
 C1107-02.....Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 C1218/C1218M-99.....Test Method for Water-Soluble Chloride in Mortar
 and Concrete
 C1240-04.....Silica Fume Used in Cementitious Mixtures
 F436/F436M-03.....Hardened Steel Washers

- F568M-02.....Carbon and Alloy Steel Externally Threaded Metric Fasteners
- F844-00.....Washers, Steel, Plain (Flat), Unhardened for General Use
- C. American Concrete Institute (ACI):
 - ACI 211.1-91.....Selecting Proportions for Normal, Heavyweight and Mass Concrete (Reapproved 2002)
- D. Precast/Prestressed Concrete Institute (PCI):
 - MNL-117-96.....Quality Control for Plants and Production of Architectural Precast Concrete Products
 - MNL-120-99.....Design Handbook - Precast and Prestressed Concrete
 - MNL-127-99.....Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products
 - MNL-135-00.....Tolerance Manual for Precast and Prestressed Concrete Construction
 - TR-6-03.....Interim Guidelines for the Use of Self-Consolidating Concrete
- E. Structural Steel Painting Council (SSPC):
 - SSPC-Paint 20 (2002).Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic).

PART 2 - PRODUCTS

2.1 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; non-reactive with concrete and suitable for producing required finishes:
 - 1. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

2.2 REINFORCING MATERIALS

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (Grade 420), deformed.
- B. Weldable Reinforcing Bars: ASTM A706/A706M, deformed.
 - 1. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized and chromate wash treated after fabrication and bending.
 - a. Plain-Steel Welded Wire Reinforcement: ASTM A185, fabricated from as-drawn steel wire into flat sheets.
 - b. Deformed-Steel Welded Wire Reinforcement: ASTM A497, flat sheet.

- C. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150, Type I or III.
 - 1. For surfaces exposed to view in finished structure, use white, same type, brand, and mill source throughout the precast concrete production.
 - 2. Standard gray Portland cement may be used for non-exposed backup concrete.
- B. Supplementary Cementitious Materials for unexposed surfaces (backup concrete) only.
 - 1. Fly Ash Admixture: ASTM C618, Class C or F with maximum loss on ignition of 3 percent.
 - 2. Metakaolin Admixture: ASTM C618, Class N.
 - 3. Silica Fume Admixture: ASTM C1240 with optional chemical and physical requirement.
 - 4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C33, with coarse aggregates complying with Class 5S. Provide and stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for entire project.
 - 1. Face-Mix Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
 - a. Gradation: Uniformly graded to match existing precast.
 - b. Eliminate off color material from exposed aggregate.
 - 2. Face-Mix Fine Aggregates: Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by Resident Engineer.
 - a. Test sand for color value in accordance with ASTM C40. Sand producing darker than specified color standard is unacceptable.
 - b. Clean washed white sand.
- D. Lightweight Coarse Aggregate: Except as modified by PCI MNL 117, ASTM C 330, with absorption less than 11 percent and free from expanded clay.
- E. Unexposed Surface (Backup) Concrete Aggregates: ASTM C33 or C330.
- F. Admixtures: Admixtures containing calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture are not permitted.

1. Coloring Admixture: ASTM C979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable and non-fading.
 2. Air Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
 3. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 4. Retarding Admixture: ASTM C494/C494M, Type B.
 5. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 7. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 8. Plasticizing Admixture for Flowable Concrete: ASTM C1017/C1017M.
- G. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

2.4 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Shapes and Plates: ASTM A36/A36M except silicon (Si) content in the range of 0 to 0.03% or 0.15 to 0.25% for materials to be galvanized. Steel with chemistry conforming to the formula $Si + 2.5P \leq 0.09$ is also acceptable.
- B. Carbon-Steel Headed Studs: ASTM A108, Grades 1018 through 1020, cold finished and bearing the minimum mechanical properties for studs as indicated under PCI MNL 117, Table 3.2.3.; AWS D1.1, Type A or B, with arc shields.
- C. Carbon-Steel Plate: ASTM A283/A283M.
- D. Malleable Iron Castings: ASTM A47/A47M. Grade 32510.
- E. Carbon-Steel Castings: ASTM A27/A27M, Grade U-60-30 (Grade 415-205).
- F. High-Strength, Low-Alloy Structural Steel: ASTM A572/A572M except silicon (Si) content in the range of 0 to 0.03% or 0.15 to 0.25% for materials to be galvanized. Steel with chemistry conforming to the formula $Si + 2.5P \leq 0.09$ is also acceptable.
- G. Carbon-Steel Structural Tubing: ASTM A500, Grade B.
- H. Wrought Carbon-Steel Bars: ASTM A675/A675M, Grade 65 (Grade 450).
- I. Deformed-Steel Wire or Bar Anchors: ASTM A496 or ASTM A706/A706M.
- J. Carbon-Steel Bolts and Studs: ASTM A307, Grade A (ASTM F568M, Property Class 4.6) carbon-steel, hex-head bolts and studs; carbon-steel nuts (ASTM A563/A563M, Grade A); and flat, unhardened steel washers (ASTM F844).
- K. High-Strength Bolts and Nuts: ASTM A325/A325M or ASTM A490/A490M, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, (ASTM A563/A563M) and hardened carbon-steel washers (ASTM F436/F436M).

L. Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A123/A123M, after fabrication, or ASTM A153/A153M, as applicable.

1. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with SSPC-Paint 20.

M. Welding Electrodes: Comply with AWS standards.

2.5 BEARING PADS AND OTHER ACCESSORIES

A. Provide bearing pads for units as follows:

1. Elastomeric Pads: AASHTO M251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer according to ASTM D2240, minimum tensile strength 15.5 MPa (2250 psi) per ASTM D412.
2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 20.7 MPa (3000 psi) with no cracking, splitting or delaminating in the internal portions of the pad. Test one specimen for each 200 pads used in the project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to ASTM D2240. Conforming to Division II, Section 18.10.2 of AASHTO LFRD, or MIL-C-882E.
4. Frictionless Pads: Tetrafluoroethylene (teflon), glass-fiber reinforced, bonded to stainless or mild-steel plates, of type required for in-service stress.
5. High-Density Plastic: Multimer, nonleaching, plastic strip.

B. Reglets: Stainless steel, ASTM A167, Type 302 felt or fiber filled or cover face opening of slots.

C. Vents and Weeps: Polyvinyl chloride plastic tubing, 4.7 mm (3/16-inch) inside diameter.

D. Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install units.

2.6 GROUT MATERIALS

A. Sand-Cement Grout: Portland Cement, ASTM C150, Type I, and clean, natural sand, ASTM C144, or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

2.7 FACING UNITS AND ACCESSORIES

- A. Refer to the related specification for facing units and facing accessories.
- B. Epoxy Anchor Hole Filler: ASTM C881, 100 percent solids, sand-filled non-shrinking, non-staining of type, class, and grade to suit application.

2.8 CONCRETE MIXES

- A. Prepare design mixes to match Resident Engineer's sample for each type of concrete required.
 - 1. Limit use of fly ash and granulated blast-furnace slag to 20 percent replacement of Portland cement by weight.
- B. Design mixes shall be prepared by a qualified independent testing agency or by qualified precast plant personnel at fabricator's option.
- C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.
- D. Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on project, to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 34.5 MPa (5000 psi).
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Release Strength at Transfer of Prestress: 24.1 MPa (3500 psi).
- E. Lightweight Concrete Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 34.5 MPa (5000 psi).
 - 2. Unit Weight: Calculated equilibrium unit weight of 1842 kg/cu.m (115 lb/cu.ft.), plus or minus 48 kg/cu.m (3 lb/cu.ft.), according to ASTM C567.
- F. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.
- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
- H. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

2.9 MOLD FABRICATION

- A. Molds: Accurately construct and maintain molds, mortar tight, within fabrication tolerances and of sufficient strength to withstand pressures

due to concrete-placement and vibration operations and temperature changes and for prestressing and detensioning operations.

1. Form joints are not permitted on faces exposed to view in the finished work.
2. Edge and Corner Treatment: Chamfered.
3. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during placing of concrete.
4. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

2.10 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
Weld headed studs and deformed bar anchors used for anchorage.
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing units to supporting and adjacent construction.
- C. Cast-in reglets, slots, holes, and other accessories in units as indicated.
- D. Cast-in openings larger than 250 mm (10 inches) in any dimension. Do not drill or cut openings or reinforcing without approval of Resident Engineer.
- E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabrication, placing, and supporting reinforcement.
 1. Place reinforcing steel and prestressing strand to maintain at least 19 mm (3/4 inch) minimum concrete cover. Increase cover requirements for reinforcing steel to 38 mm (1-1/2 inches) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete.
 2. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.

1. At the fabricator's option either of the following mix design/casting techniques may be used:
 - a. A single design mix throughout the entire thickness of panel.
 - b. Design mixes for facing and backup; using cement and aggregates for each type as indicated, for consecutive placement in the mold. Use cement and aggregate specified for facing mix, use cement and aggregate for backup mix complying with criteria specified as selected by the fabricator.
- G. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 117.
 1. Place backup concrete to ensure bond with face mix concrete.
 2. Place self-consolidating concrete without vibration in accordance with PCI TR-6.
- H. Identify pickup points of units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each unit on a surface that will not show in finished structure.
- I. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat.
- J. Repair damaged units to meet acceptability requirements of PCI MNL 117 and the Resident Engineer.

2.11 FABRICATION TOLERANCES

- A. Fabricate units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
 1. Additional Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.
 - a. Location of Bearing Surface from End of Member: Plus or Minus 6 mm (1/4 inch).
 - b. Position of Sleeve: Plus or Minus 13 mm (1/2 inch).
- B. Fabricate architectural trim units such as sills, lintels, coping, cornices, quoins, medallions, bollards, benches, planters, and pavers, with tolerances meeting PCI MNL 135.

2.12 FINISHES

- A. Panel faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight and sharp. Finish exposed-face surfaces of units to match approved design reference sample and as follows:
 1. PCI's "Architectural Precast Concrete -Color and Texture Selection Guide," of plate numbers indicated.

2. Textured-Surface Finish: Impart by form liners to provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.
- B. Finish exposed top and bottom surfaces of units to match face-surface finish.
- C. Finish unexposed surfaces by smooth steel-trowel finish.

2.13 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete according to Section 01 45 29, TESTING LABORATORY SERVICES and PCI MNL 117 requirements respectively. If using self-consolidating concrete also test and inspect according to PCI TR-6.
- B. Testing: If there is evidence that the concrete strength of precast concrete units may be deficient, Precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to PCI MNL 117:
 1. Test results will be made in writing on the same day that tests are performed, with copies to Resident Engineer, Contractor, and precast concrete fabricator. Test reports will include the information required in Section TESTING LABORATORY SERVICES and the following:
 - a. Identification mark and type of precast concrete units represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
- C. Defective or Damaged Work: Units that do not comply with acceptability requirements, including concrete strength, manufacturing tolerances, and color and texture range are unacceptable. Chipped, spalled or cored units may be repaired, if repaired units match the visual mock-up. The Resident Engineer reserves the right to reject any unit if it does not match the accepted samples and visual mock-up. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Deliver anchorage devices that are embedded in or attached to the building structural frame or foundation before start of such work. Provide locations, setting diagrams, and templates for the proper installation of each anchorage device.
- B. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed

with installation only after unsatisfactory conditions have been corrected.

- C. Do not install units until supporting structure is structurally ready to receive loads from precast.

3.2 ERECTION

- A. Erect level, plumb and square within the specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
 - 1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
 - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 3. Remove projecting lifting devices and use sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.
 - 4. Unless otherwise shown provide for uniform joint widths of 19mm (3/4 inch).
- B. Connect units in position by bolting, welding, grouting, or as otherwise indicated on approved Erection Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.
 - 1. Disruption of flashing continuity by connections is not permitted.
 - 2. Welding: Comply with applicable requirements for welding.
 - a. Protect units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
 - b. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS.
 - c. Clean weld affected metal surfaces and apply a minimum 100 µm (0.004 inch) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A780.
 - d. Visually inspect all welds critical to precast connections. Visually check all welds for completion and remove, reweld or repair all defective welds.
 - 3. At bolted connections, use lock washers, tack welding, or other acceptable means to prevent loosening of nuts after final adjustment.
 - a. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connection apply

specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.

4. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
- C. Attachments: Upon approval of Resident Engineer, precast pre-stressed products may be drilled or "shot" for fasteners or small openings. Provided reinforcing or pre-stressing steel is not damaged or cut.
 1. Should spalling occur, repair according to this specification section.
- D. Venting and Weeps: Where precast concrete panels form the outer wythe of cavity wall construction, vent the cavity wall.
 1. Use polyvinyl chloride plastic tubing to vent the cavity.
 2. Place plastic vent tubes "tilted down and out" in horizontal and vertical joints.
 3. Space vent tubes in accordance with shop drawings, but not less than two vents per panel or approximately 1220 mm (4 feet) on centers.
- E. Setting: Where shown, fill joints with cement mortar specified in Section 04 05 13, MASONRY MORTARING.
 1. Clean surfaces forming beds and other joints for precast concrete panels of dust, dirt, and other foreign matter, and wet thoroughly to prevent suction before precast concrete, elements are set.
 2. Set precast element level and true to line with uniform joints filled completely with mortar.
 - a). Rake out joints 25 mm (1-inch) deep for pointing or sealants.
 - b). Joints required to have only sealant: Kept free of mortar for full depth.
 3. Keep exposed faces of precast concrete elements free of mortar.
 4. Remove wedges, spacers, or other appliances which are likely to cause staining from joints.
 5. Where parging is shown, parge back of elements solid with mortar. Apply parging without skips or holidays.
- F. Pointing: Wash and brush clean, leaving joints free from loose mortar, dust and other foreign material.
 1. Carefully point with a slightly concave joint.
 2. Use same material and color sand used in fabrication of precast concrete elements when specified in Section 09 06 00, SCHEDULE FOR FINISHES.
- G. Sealing of Joints: Where shown and where required to make work watertight: clean, dry and seal joints between precast concrete elements and between

precast elements and adjoining materials as specified in Section 07 92 00, JOINT SEALANTS.

3.3 ERECTION TOLERANCES

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

3.4 FIELD QUALITY CONTROL

- A. Refer to Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Testing agency will report test results promptly and in writing to Contractor and Resident Engineer.
- C. Repair or remove and replace work that does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS

- A. Repairs will be permitted provided structural adequacy of units and appearance are not impaired.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 6 m (20 feet).
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.
- D. Remove and replace damaged units when repairs do not meet requirements.

3.6 CLEANING

- A. Clean all surfaces of precast concrete to be exposed to view, as necessary, prior to shipping.
- B. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

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**SECTION 04 05 13
MASONRY MORTARING**

PART 1 - GENERAL

1.1 DESCRIPTION:

Section specifies mortar materials and mixes.

1.2 RELATED WORK:

A. Mortar used in Section:

1. Section 03 45 00, PRECAST ARCHITECTURAL CONCRETE.
2. Section 04 20 00, UNIT MASONRY.
3. Section 04 05 31, MASONRY TUCK POINTING.
4. Section 04 72 00, CAST STONE MASONRY.

B. Mortar Color: Section 09 06 00, SCHEDULE FOR FINISHES.

1.3 TESTING LABORATORY-CONTRACTOR RETAINED

- A. Engage a commercial testing laboratory approved by Resident Engineer to perform tests specified below.
- B. Submit information regarding testing laboratory's facilities and qualifications of technical personnel to Resident Engineer.

1.4 TESTS

- A. Test mortar and materials specified.
- B. Certified test reports.
- C. Identify materials by type, brand name and manufacturer or by origin.
- D. Do not use materials until laboratory test reports are approved by Resident Engineer.
- E. After tests have been made and materials approved, do not change without additional test and approval of Resident Engineer.
- F. Testing:
 1. Test materials proposed for use for compliance with specifications in accordance with test methods contained in referenced specifications and as follows:
 2. Mortar:
 - a. Test for compressive strength and water retention; ASTM C270.
 - b. Mortar compressive strengths 28 days as follows:
Type M: Minimum 17230 kPa (2500 psi) at 28 days.
Type S: Minimum 12400 kPa (1800 psi) at 28 days.
Type N: Minimum 5170 kPa (750 psi) at 28 days.
 3. Cement:
 - a. Test for water soluble alkali (nonstaining) when nonstaining cement is specified.
 - b. Nonstaining cement shall contain not more than 0.03 percent water soluble alkali.

- 4. Sand: Test for deleterious substances, organic impurities, soundness and grading.
- G. During progress of work, testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES, takes and tests samples as specified in that section. Testing procedures and test methods in ASTM C780.

1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Certificates:
 - 1. Indicating that following items meet specifications:
 - a. Portland cement.
 - b. Masonry cement.
 - c. Hydrated lime.
 - d. Fine aggregate (sand).
 - e. Color admixture.
- C. Laboratory Test Reports:
 - 1. Mortar, each type.
 - 2. Admixtures.
- D. Manufacturer's Literature and Data:
 - 1. Cement, each kind.
 - 2. Hydrated lime.
 - 3. Admixtures.
 - 4. Liquid acrylic resin.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver masonry materials in original sealed containers marked with name of manufacturer and identification of contents.
- B. Store masonry materials under waterproof covers on planking clear of ground, and protect damage from handling, dirt, stain, water and wind.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - C40-04.....Organic Impurities in Fine Aggregates for
Concrete
 - C91-05.....Masonry Cement
 - C109-07.....Compressive Strength of Hydraulic Cement Mortars
(Using 2-in. or 50-MM Cube Specimens)
 - C144-04.....Aggregate for Masonry Mortar
 - C150-05.....Portland Cement
 - C207-06.....Hydrated Lime for Masonry Purposes

C270-07.....	Mortar for Unit Masonry
C307-03.....	Tensile Strength of Chemical - Resistant Mortar, Grouts, and Monolithic Surfacing
C321-00/R05.....	Bond Strength of Chemical-Resistant Mortars
C348-02.....	Flexural Strength of Hydraulic Cement Mortars
C595-08.....	Blended Hydraulic Cement
C780-07.....	Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C979-05.....	Pigments for Integrally Colored Concrete
C1329-05.....	Mortar Cement

PART 2 - PRODUCTS

2.1 HYDRATED LIME

ASTM C207, Type S.

2.2 AGGREGATE FOR MASONRY MORTAR

A. ASTM C144 and as follows:

1. Light colored sand for mortar for laying face brick.
2. White plastering sand meeting sieve analysis for mortar joints for pointing.

B. Test sand for color value in accordance with ASTM C40. Sand producing color darker than specified standard is unacceptable.

2.3 BLENDED HYDRAULIC CEMENT

ASTM C595, Type IS, IP.

2.4 MASONRY CEMENT

A. ASTM C91. Type N, S, or M.

B. Use white masonry cement whenever white mortar is specified.

2.5 PORTLAND CEMENT

A. ASTM C150, Type I.

B. Use white Portland cement wherever white mortar is specified.

2.6 LIQUID ACRYLIC RESIN

A formulation of acrylic polymers and modifiers in liquid form designed for use as an additive for mortar to improve physical properties.

2.7 WATER

Potable, free of substances that are detrimental to mortar, masonry, and metal.

2.8 POINTING MORTAR

A. For Cast Stone or Precast Concrete: Proportion by volume; One part white Portland cement, two parts white sand, and 1/5 part hydrated lime.

2.9 MASONRY MORTAR

A. Conform to ASTM C270.

B. Admixtures:

1. Do not use mortar admixtures, and color admixtures unless approved by Resident Engineer.
2. Submit laboratory test report showing effect of proposed admixture on strength, water retention, and water repellency of mortar.
3. Do not use antifreeze compounds.

C. Colored Mortar:

1. Maintain uniform mortar color for exposed work throughout.
2. Match mortar color in approved sample or mock-up.
3. Color of mortar for exposed work in alteration work to match color of existing mortar unless specified otherwise in section 09 06 00, SCHEDULE FOR FINISHES.

D. Color Admixtures:

1. Proportion as specified by manufacturer.
2. For color, see Section 09 06 00, SCHEDULE FOR FINISHES.

2.10 COLOR ADMIXTURE

- A. Pigments: ASTM C979.
- B. Use mineral pigments only. Organic pigments are not acceptable.
- C. Pigments inert, stable to atmospheric conditions, nonfading, alkali resistant and water insoluble.

PART 3 - EXECUTION

3.1 MIXING

- A. Mix in a mechanically operated mortar mixer.
 1. Mix mortar for at least three minutes but not more than five minutes.
- B. Measure ingredients by volume. Measure by the use of a container of known capacity.
- C. Mix water with dry ingredients in sufficient amount to provide a workable mixture which will adhere to vertical surfaces of masonry units.
- D. Mortar that has stiffened because of loss of water through evaporations:
 1. Re-tempered by adding water to restore to proper consistency and workability.
 2. Discard mortar that has reached its initial set or has not been used within two hours.
- E. Pointing Mortar:
 1. Mix dry ingredients with enough water to produce a damp mixture of workable consistency which will retain its shape when formed into a ball.
 2. Allow mortar to stand in dampened condition for one to 1-1/2 hours.
 3. Add water to bring mortar to a workable consistency prior to application.

3.2 MORTAR USE LOCATION

- A. Use Type M mortar for precast concrete panels, and waterproof parging below grade.
- B. For brick veneer over frame back up walls, use Type S masonry cement or mortar cement mortar.
- C. Use Type N mortar for tuck pointing work.
- D. Use pointing mortar for items specified.

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SECTION 04 20 00
UNIT MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies requirements for construction of exterior face brick and interior non-bearing concrete masonry unit walls.

1.2 RELATED WORK

- A. Precast concrete units: Section 03 45 00, PRECAST ARCHITECTURAL CONCRETE
- B. Mortars: Section 04 05 13, MASONRY MORTARING.
- C. Calcium silicate manufactured stone masonry units: Section 04 73 13, CALCIUM SILICATE MANUFACTURED STONE MASONRY.
- D. Steel lintels and shelf angles: Section 05 50 00, METAL FABRICATIONS.
- E. Flashing: Section 07 60 00, FLASHING AND SHEET METAL.
- F. Sealants and sealant installation: Section 07 92 00, JOINT SEALANTS.
- G. Color and texture of masonry units: Section 09 06 00, SCHEDULE FOR FINISHES.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- B. Samples:
 - 1. Face brick, sample panel, 200 mm by 400 mm (8 inches by 16 inches,) showing full color range and texture of bricks, bond, and proposed mortar joints.
 - 2. Anchors, and ties, one each and joint reinforcing 1200 mm (48 inches) long.
- C. Shop Drawings:
 - 1. Drawings, showing reinforcement, applicable dimensions and methods of hanging lintel masonry.
- D. Manufacturer's Literature and Data:
 - 1. Anchors, ties, and reinforcement.

1.4 SAMPLE PANEL

- A. Before starting masonry, lay up a sample panel in accordance with Masonry Standards Joint Committee (MSJC) and Brick Industry Association (BIA).
 - 1. Use masonry units from random cubes of units delivered on site.
 - 2. Include reinforcing, ties, and anchors.
- B. Use sample panels approved by Resident Engineer for standard of workmanship of new masonry work.
- C. Use sample panel to test cleaning methods.

1.5 WARRANTY

Warrant exterior masonry walls against moisture leaks and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be five years.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A951-06.....Steel Wire for Masonry Joint Reinforcement.
 - C216-07.....Facing Brick (Solid Masonry Units Made From Clay or Shale)
 - C612-04.....Mineral Fiber Block and Board Thermal Insulation
 - C744-05.....Prefaced Concrete and Calcium Silicate Masonry Units.
 - D1056-07.....Flexible Cellular Materials - Sponge or Expanded Rubber
 - D2240-05.....Rubber Property - Durometer Hardness
 - D3574-05.....Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams
 - F1667-05.....Fasteners: Nails, Spikes and Staples
- C. Masonry Industry Council:
 - All Weather Masonry Construction Manual, 2000.
- D. Federal Specifications (FS):
 - FF-S-107C-00.....Screws, Tapping and Drive
- E. Brick Industry Association - Technical Notes on Brick Construction (BIA):
 - 11-1986.....Guide Specifications for Brick Masonry, Part I
 - 11A-1988.....Guide Specifications for Brick Masonry, Part II
 - 11B-1988.....Guide Specifications for Brick Masonry, Part III Execution
 - 11C-1998.....Guide Specification for Brick Masonry Engineered Brick Masonry, Part IV
 - 11D-1988.....Guide Specifications for Brick Masonry Engineered Brick Masonry, Part IV continued
- F. Masonry Standards Joint Committee; Specifications for Masonry Structures (ACI 530.1-05/ASCE 6-05/TMS 602-99) (MSJC).

PART 2 - PRODUCTS**2.1 BRICK****A. Face Brick:**

1. ASTM C216, Grade SW, Type FBX.
2. Brick when tested in accordance with ASTM C67: Classified slightly efflorescent or better.
3. Modular: W 3 5/8", H 2 1/4", L 7 5/8", 3 courses = 8".
4. Color and Texture: See Schedule for Finishes, section 09 06 00.

2.2 CONCRETE MASONRY UNITS**A. Hollow Concrete Masonry Units: ASTM C90.**

1. Unit Weight: Normal weight.
2. Modular: W 5 5/8", H 7 5/6", L 15 5/8".
3. Color and Texture: Natural grey, regular face.

2.3 ANCHORS, TIES, AND REINFORCEMENT**A. Joint Reinforcement:**

1. Form from No. 9 wire complying with ASTM A951.
2. Galvanized after fabrication.
3. Joint reinforcement at least 3048 mm (10 feet) in length.
4. Joint reinforcement in rolls is not acceptable.
5. Joint reinforcement that is crimped to form drip is not acceptable.

B. Adjustable Veneer Anchor for Frame Walls:

1. Two piece, adjustable anchor and tie.
2. Loop Type:
 - a. Anchor: Screw-on galvanized steel anchor plate 2.75 mm (0.11 inch) by 19 mm (3/4 inch) wide by 225 mm (9 inches) long, configured with legs to accommodate sheathing and provide positive contact with the metal wall studs, with 9 mm (0.35 inch) offset and 100 mm (4 inch) adjustment. Provide 5 mm (0.20 inch) hole at each end for fasteners.
 - b. Ties: Triangular tie, fabricated of 5 mm (0.1875 inch) diameter galvanized cold drawn steel wire. Ties long enough to engage the anchor, accommodate the width of the air cavity, and be embedded not less than 50 mm (2 inches) into the bed joint of the masonry veneer.

2.4 PREFORMED COMPRESSIBLE JOINT FILLER

- A. Thickness and depth to fill the joint as specified.
- B. Closed Cell Neoprene: ASTM D1056, Type 2, Class A, Grade 1, B2F1.
- C. Non-Combustible Type: ASTM C612, Class 5, 1800 degrees F.

2.5 ACCESSORIES

- A. Weep Hole Wicks: Glass fiber ropes, 10 mm (3/8 inch) minimum diameter, 356 mm (14 inches) long.
- B. Box Board:
 - 1. Mineral Fiber Board: ASTM C612, Class 1.
 - 2. 51 mm (2 inch) thickness.
 - 3. Other spacing material having similar characteristics may be used subject to the Resident Engineer's approval.
- C. Masonry Cleaner:
 - 1. Detergent type cleaner selected for each type masonry used.
 - 2. Acid cleaners are not acceptable.
 - 3. Use soapless type specially prepared for cleaning brick or concrete masonry as appropriate.
- D. Fasteners:
 - 1. Screws: FS-FF-S-107, Type A, AB, SF thread forming or cutting.
- E. Mortar Dropping Protection:
 - 1. Trapezoidal shaped mortar dropping collection device for masonry cavity walls.

PART 3 - EXECUTION**3.1 JOB CONDITIONS**

- A. Protection:
 - 1. Cover tops of walls with nonstaining waterproof covering, when work is not in progress. Secure to prevent wind blow off.
 - 2. On new work protect base of wall from mud, dirt, mortar droppings, and other materials that will stain face, until final landscaping or other site work is completed.
- B. Cold Weather Protection:
 - 1. Masonry may be laid in freezing weather when methods of protection are utilized.
 - 2. Comply with MSJC and "Hot and Cold Weather Masonry Construction Manual".

3.2 CONSTRUCTION TOLERANCES

- A. Lay masonry units plumb, level and true to line within the tolerances as per MSJC requirements and as follows:
- B. Maximum variation from plumb:
 - 1. In 3048 mm (10 feet) - 6 mm (1/4 inch).
 - 2. In 6096 mm (20 feet) - 10 mm (3/8 inch).
 - 3. In 12 192 mm (40 feet) or more - 13 mm (1/2 inch).
- C. Maximum variation from level:
 - 1. In any bay or up to 6096 mm (20 feet) - 6 mm (1/4 inch).

2. In 12 192 mm (40 feet) or more - 13 mm (1/2 inch).
- D. Maximum variation from linear building lines:
 1. In any bay or up to 6096 mm (20 feet) - 13 mm (1/2 inch).
 2. In 12 192 mm (40 feet) or more - 19 mm (3/4 inch).
- E. Maximum variation in cross-sectional dimensions of columns and thickness of walls from dimensions shown:
 1. Minus 6 mm (1/4 inch).
 2. Plus 13 mm (1/2 inch).
- F. Maximum variation in prepared opening dimensions:
 1. Accurate to minus 0 mm (0 inch).
 2. Plus 6 mm (1/4 inch).

3.3 INSTALLATION GENERAL

- A. Keep finish work free from mortar smears or spatters, and leave neat and clean.
- B. Anchor masonry as specified in Paragraph, ANCHORAGE.
- C. Wall Openings:
 1. Fill hollow metal frames built into masonry walls and partitions solid with mortar as laying of masonry progresses.
 2. If items are not available when walls are built, prepare openings for subsequent installation.
- D. Tooling Joints:
 1. Do not tool until mortar has stiffened enough to retain thumb print when thumb is pressed against mortar.
 2. Tool while mortar is soft enough to be compressed into joints and not raked out.
 3. Finish joints in exterior face masonry work with a jointing tool, and provide smooth, water-tight concave joint unless specified otherwise.
- E. Lintels:
 1. Provide steel lintels at all openings.
 2. Length for minimum bearing of 102 mm (4 inches) at ends.
- F. Wall, Furring, and Partition Units:
 1. Lay out field units to provide for running bond of walls and partitions, with vertical joints in second course centering on first course units unless specified otherwise.
 2. Align head joints of alternate vertical courses.
 3. At sides of openings, balance head joints in each course on vertical center lines of openings.
 4. Use no piece shorter than 100 mm (4 inches) long.
 5. Use not less than 100 mm (4 inches) nominal thick masonry for free standing furring unless shown otherwise.

- G. Use not less than 100 mm (4 inches) nominal thick masonry for fireproofing steel columns unless shown otherwise.
- H. Before connecting new masonry with previously laid, remove loosened masonry or mortar, and clean and wet work in place as specified under wetting.
- I. When new masonry partitions start on existing floors, machine cut existing floor finish material down to concrete surface.
- J. Wetting and Wetting Test:
 - 1. Test and wet brick in accordance with BIA 11B.

3.4 ANCHORAGE

- A. Veneer to Frame Walls:
 - 1. Use adjustable veneer anchors. Ties shall extend horizontally from the mortar bed to the anchor plate. Keep space between masonry wall and sheathing free of mortar and other rigid material.
 - 2. Fasten anchor plate to stud through sheathing with self drilling and tapping screws, one at each end of anchor plate.
 - 3. Space anchors not more than 406 mm (16 inches) on center vertically at each stud.
 - 4. Provide sealant at each and every anchor penetration through the weather barrier. Sealant type to be approved by weather barrier manufacturer for use with assemblies indicated.

3.5 REINFORCEMENT

- A. Joint Reinforcement:
 - 1. Locate joint reinforcement in mortar joints at 400 mm (16 inch) maximum vertical intervals.
 - 2. Additional joint reinforcement is required in mortar joints at both 203 mm (8 inches) and 406 (16 inches) above and below windows, doors, louvers and similar openings in masonry, except where other type anchors are required for anchorage of masonry to concrete structure.

3.6 BRICK EXPANSION JOINTS

- A. Provide brick expansion (BEJ) joints where shown on drawings.
- B. Provide brick expansion joints additionally as required to comply with locations recommended by the Brick Institute of America.
- C. Keep joint free of mortar and other debris.
- D. Where joints occur in masonry walls.
 - 1. Install preformed compressible joint filler in brick wythe.
 - 2. Install filler, backer rod, and sealant on exposed faces.
- E. Interrupt steel joint reinforcement at expansion joints unless otherwise shown.
- F. Fill opening in exposed face of expansion joints with sealant as specified in Section 07 92 00, JOINT SEALANTS.

3.7 BUILDING EXPANSION AND SEISMIC JOINTS

- A. Keep joint free of mortar. Remove mortar and other debris.
- B. Install non-combustible, compressible type joint filler to fill space completely except where sealant is shown on joints in exposed finish work.
- C. Where joints are on exposed faces, provide depth for backer rod and sealant as specified in Section 07 92 00, JOINT SEALANTS, unless shown otherwise.

3.8 ISOLATION SEAL

- A. Where full height walls or partitions lie parallel or perpendicular to and under structural beams or shelf angles, provide a separation between walls or partitions and bottom of beams or shelf angles not less than the masonry joint thickness unless shown otherwise.
- B. Insert in the separation, a continuous full width strip of non-combustible type compressible joint filler except as detailed otherwise.
- C. Where exposed in finish work, cut back filler material in the joint enough to allow for the joint to be filled with sealant material specified in Section 07 92 00, JOINT SEALANTS.

3.9 BRICKWORK

- A. Lay clay brick in accordance with BIA Technical Note 11 series.
- B. Laying:
 - 1. Lay brick in running bond with course of masonry bonded at corners unless shown otherwise. Match bond of existing building on alterations and additions.
 - 2. Maintain bond pattern throughout. Refer to Architectural Elevation for bonding patterns.
 - 3. Do not use brick smaller than half-brick at any angle, corner, break or jamb.
 - 4. Where length of cut brick is greater than one half but less than a whole brick, maintain the vertical joint location of such units.
 - 5. Lay exposed brickwork joints symmetrical about center lines of openings.
 - 6. Before starting work, lay facing brick on foundation wall and adjust bond to openings, angles, and corners.
- C. Joints:
 - 1. Exterior and interior joint widths: Lay for three equal joints in 203 mm (eight inches) vertically, unless shown otherwise.
- D. Weep Holes:
 - 1. Install weep holes at 610 mm (24 inches) on center in bottom of vertical joints of exterior masonry veneer or cavity wall facing over foundations, bond beams, and other water stops in the wall.

2. Form weep holes using wicks made of glass fiber ropes turned up 203 mm (8 inches) in cavity. Anchor top of strip to cavity insulation to securely hold in place.

E. Cavity Type Exterior Walls:

1. Keep air space clean of mortar accumulations and debris.
 - a. Clean cavity by use of hard rubber, wood or metal channel strips having soft material on sides contacting wythes.
 - b. Lift strips with wires before placing next courses of horizontal joint reinforcement or adjustable cavity wall ties.
2. Insulated Cavity Type Exterior Walls:
 - a. Install the insulation against the cavity face of sheathed stud wall.
 - b. Place insulation and bond to surface of sheathed stud wall with a bonding agent as recommended by the manufacturer of the insulation.
 - c. Lay the outer masonry wythe up with an air space between insulation and masonry units.
3. Veneer Framed Walls:
 - a. Build with 102 mm (4 inches) of face brick over sheathed stud wall with air space.
 - b. Keep air space clean of mortar accumulations and debris.

3.10 CONCRETE MASONRY

A. Kind and Users:

1. Masonry assemblies shall meet the required fire resistance in fire rated partitions of type and construction that will provide fire rating as shown.

B. Laying:

1. Lay concrete masonry units with 10 mm (3/8 inch) joints, with a bond overlap of not less than 1/4 of the unit length, except where stack bond is required.
2. Do not wet concrete masonry units before laying.
3. Bond external corners of partitions by overlapping alternate courses.
4. Lay first course in a full mortar bed.
5. Set anchorage items as work progress.
6. Where ends of anchors, bolts, and other embedded items, project into voids of units, completely fill such voids with mortar or grout.
7. Provide a 6 mm (1/4 inch) open joint for caulking between existing construction, concrete work, and abutting masonry partitions.
8. Lay concrete masonry units with full face shell mortar beds and fill head joint beds for depth equivalent to face shell thickness.

3.11 POINTING

- A. Fill joints with pointing mortar using rubber float trowel to rub mortar solidly into raked joints.
- B. Wipe off excess mortar from joints of architectural precast units with dry cloth.
- C. Finish exposed joints in finish work with a jointing tool to provide a smooth concave joint unless specified otherwise.
- D. At joints with existing work match existing joint.

3.12 PLACING REINFORCEMENT

- A. General: Clean reinforcement of loose rust, mill scale, earth, ice or other materials which will reduce bond to mortar. Do not use reinforcement with kinks or bends not shown on the Contract Drawings or final shop drawings, or reinforcement with reduced cross-section due to excessive rusting or other causes.
- B. Position reinforcement accurately at the spacing indicated. . Horizontal reinforcement shall be placed as the masonry work progresses.
- C. Provide not less than 152 mm (6 inches) minimum lap, or as required by governing code.
- D. Embed metal ties in mortar joints as work progresses, with a minimum embedment in mortar joint of 51 mm (2 inches)..
- E. Use prefabricated "L" and "T" sections to provide continuity at corners and intersections. Cut and bend joint reinforcement as recommended by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
- F. Anchoring: Anchor reinforced masonry work to supporting structure as indicated.

3.13 CLEANING AND REPAIR

- A. General:
 - 1. Clean exposed masonry surfaces on completion.
 - 2. Protect adjoining construction materials and landscaping during cleaning operations.
 - 3. Cut out defective exposed new joints to depth of approximately 19 mm (3/4 inch) and repoint.
 - 4. Remove mortar droppings and other foreign substances from wall surfaces.
- B. Brickwork:
 - 1. First wet surfaces with clean water, then wash down with a solution of soapless detergent. Do not use muriatic acid.
 - 2. Brush with stiff fiber brushes while washing, and immediately thereafter hose down with clean water.

3. Free clean surfaces of traces of detergent, foreign streaks, or stains of any nature.

C. Concrete Masonry Units:

1. Immediately following setting, brush exposed surfaces free of mortar or other foreign matter.

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SECTION 04 73 13
CALCIUM SILICATE MANUFACTURED STONE MASONRY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Calcium silicate masonry units.
- B. Mortar for unit masonry.
- C. Reinforcement, anchorages, and accessories.

1.2 RELATED SECTIONS

- A. Section 034500 - Precast Architectural Concrete.
- B. Section 040513 - Mortar and Grout.
- C. Section 042000 - Unit Masonry.
- D. Section 055000 - Metal Fabrications.
- E. Section 054000 - Metal Framing.
- F. Section 072113 - Building Insulation: Insulation for cavity spaces.
- G. Section 079200 - Sealants and Caulking.
- H. Section 090600 - Schedule for Finishes for color and texture.

1.3 REFERENCES

- A. ACI 530/ASCE 5/TMS 402-99: Building Code Requirements for Masonry Structures.
- B. ACI 530.1/ASCE 6/TMS 602-99: Specifications for Masonry Structures.
- C. ASTM A153/A153M-98: Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- D. ASTM A580/A580M-98: Standard Specification for Stainless Steel Wire.
- E. ASTM C73-97a: Standard Specification for Calcium Silicate Face Brick.
- F. ASTM C144-99: Standard Specification for Aggregate for Masonry Mortar.
- G. ASTM C150-98: Standard Specification for Portland Cement.
- H. ASTM C207-91(1997): Standard Specification for Hydrated Lime for Masonry Purposes.
- I. ASTM C270-99: Standard Specification for Mortar for Unit Masonry.
- J. International Masonry Institute All-Weather Council: Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- K. Masonry Advisory Council: Hot and Cold Weather Construction.

1.4 QUALITY ASSURANCE

- A. Installer: Company or person specializing in commercial masonry work with five years experience.
- B. Installation of Masonry Work: to ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602.

1.5 TESTS

- A. Test samples in accordance with indicated standards.

1.6 SAMPLES

- A. Submit one sample of calcium silicate masonry units to illustrate color and texture.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver mortar materials in original unbroken and undamaged packages with the maker's name and brand distinctly marked thereon, and upon delivery store in a shed until used on the work.
- B. Store or pile sand on a plank platform and protect from dirt and rubbish. Store mortar materials and sand in such a manner as to prevent deterioration or contamination by foreign materials.
- C. Deliver masonry units to the site in approved protective film. Prevent damage to units.
- D. Lift skids with proper and sufficiently long slings or forks with protection to prevent damage to units. Protect edges and corners.
- E. Store masonry units in a manner designed to prevent damage and staining of units.
- F. Stack units on timbers or platforms at least 75 mm 3" above grade.
- G. Place polyethylene or other plastic film between wood and other finished surfaces of units when stored for extended periods of time.
- H. Cover stored units with protective enclosure if exposed to weather.
- I. Do not use salt or calcium-chloride to remove ice from masonry surfaces.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Perform work to requirements of Section 010100.
- B. Maintain materials and surrounding air temperature to minimum 10 degrees C 52 degrees F prior to and 48 hours after completion of masonry work.
- C. Cold Weather Requirements: to MAC - Hot and Cold Weather Construction.
- D. Conform to requirements of ACI 530.1/ASCE 6/TMS 602, Specifications for Masonry Structures, PART 1.8.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers of calcium silicate masonry units having Products considered acceptable for use:
 - 1. Arriscraft International Inc.
 - 2. Approved equal substitute.

2.2 MORTAR MATERIALS

- A. Portland Cement: to ASTM C150, Type I color as selected by Consultant.
- B. Hydrated Lime: to ASTM C207, Type S.
- C. Mortar Aggregate: to ASTM C144, standard masonry type; clean, dry, protected against dampness, freezing, and foreign matter.
- D. Color Pigment: natural oxide pigment.

E. Water: potable, clean and free of deleterious amounts of acids, alkalies or organic materials.

2.3 MANUFACTURED UNITS

A. Calcium Silicate Masonry Units: to ASTM C73, Grade SW; solid units having been pressure formed and autoclaved; 90 mm (3-5/8") bed depth; modular sizes 12" x 24"; sandblasted finish on exposed faces and ends; special shapes as indicated; color as selected by Consultant, and having the following typical average properties when tested to the identified standard:

1. Compressive Strength: 45.5 MPa 6600 psi, to ASTM C170.
2. Absorption: 8.8 percent, to ASTM C97.
3. Density: 2070 kg/m³ 129 lbs/ft³, to ASTM C97.
4. Modulus of Rupture: 5.3 MPa 770 psi, to ASTM C99.

2.4 REINFORCEMENT AND ANCHORAGES

A. Bed Joint Reinforcement: Single-wire type; 4.8 mm (0.186"); hot dipped galvanized steel, to ASTM A82.

B. Anchors: See Section 042000.

C. Ties: as specified under Section 042000.

2.5 MASONRY FLASHING

A. Flexible Flashing: Sheet polyethylene; 0.5 mm (0.020") thick. Galvanized steel where exposed to exterior.

2.6 ACCESSORIES

A. Mortar: as specified in Section 040513.

2.7 MORTAR MIXES

A. Mortar for Calcium Silicate Masonry Units: to CSA A179 ASTM C270, Proportion specification, 1 part Portland cement, 1 part hydrated lime, 6 parts mortar aggregate by volume for both cementitious materials and aggregate; integral color as selected by Consultant.

2.8 MORTAR MIXING

A. Thoroughly mix mortar ingredients in proper quantities needed for immediate use to requirements of ASTM C270.

B. Add mortar color and admixtures to requirements of manufacturer's instructions.

C. Provide uniformity of mix and coloration.

D. Take representative samples for testing consistency of strength and color according to CSA A179 ASTM C780.

E. Use mortar within 2 hours after mixing at temperatures of 84 degrees F, or 2-1/2 hours at temperatures under 52 degrees F.

2.9 FINISHES

A. Hot Dip Galvanizing: to ASTM A153, Class B2.

2.10 FABRICATION TOLERANCES

A. Fabricate calcium silicate masonry units to the following tolerances:

1. Unit Length: plus or minus 1.5 mm (1/16").
2. Unit Height: plus or minus 1.5 mm (1/16").
3. Deviation From Square: plus or minus 1.5 mm (1/16"), with measurement taken using the longest edge as the base.
4. Bed Depth: plus or minus 3 mm (1/8").
5. Custom Dimensions: plus or minus 3 mm (1/8").
6. Unit Face Deviations: plus or minus 10 mm (3/8")

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are ready to receive work.
- B. Beginning of installation means acceptance of site conditions.

3.2 PREPARATION

- A. Supply metal anchors to Section 042000 for placement. Direct correct placement.
- B. Verify items provided by other sections of work are properly sized and located.

3.3 CUTTING OF MASONRY UNITS

- A. Cut masonry units with wet-saw.
- B. Pre-soak units using clean water prior to cutting.
- C. Clean cut units using a stiff fibre brush and clean water. Allow units to surface dry prior to placement.

3.4 COURSING

- A. Place masonry to lines and levels indicated.
- B. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.
- C. Lay masonry units in half-running bond.
- D. Course one masonry unit and one mortar joint to equal 300 mm (12").
- E. Maintain mortar joint thickness of 10 mm (3/8").
- F. Tool joints to a concave finish.

3.5 PLACING AND BONDING

- A. Lay masonry in full bed of mortar, properly jointed with other work. Buttering corners of joints, and deep or excessive furrowing of mortar joints.
- B. Fully bond intersections, and external corners.
- C. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- D. Do not adjust masonry units after laying. Where resetting of masonry is required, remove, clean units and reset in new mortar.

3.6 CAVITY WALL

- A. Install weep vents in veneer at 600 mm (24") OC horizontally above through-wall flashing and at bottom of walls.

B. Install cavity vents at same spacing.

3.7 TOLERANCES

A. Variation in Alignment from Unit to Adjacent Unit: 1.5 mm (1/16") maximum.

B. Variation of Mortar Joint Thickness: 3 mm every metre (1/8" every 36").

3.8 REINFORCEMENT AND ANCHORAGES

A. Embed wall ties in masonry back-up for veneer at maximum 16 OC vertically and 16 OC horizontally.

B. Increase quantity of wall ties around perimeter of openings, at wall terminations and corners placed within 200 mm (8") of openings and edges of masonry.

3.9 MASONRY FLASHING

A. Extend flashing through veneer, turn up and seal to concrete and seal into sheathing over steel stud framed back-up.

B. Lap end joints and seal watertight.

3.10 LINTELS

A. Install lintels as scheduled.

3.11 MOVEMENT CONTROL JOINTS

A. Construct movement joints in locations noted on drawings.

B. Do not continue horizontal joint reinforcing across movement control joints.

C. Form movement control joints by leaving head joints between stacked units void of mortar, ready for application of bond breaker and joint sealant.

D. Size joint in accordance with Section 079200 for sealant performance.

3.12 CLEANING

A. Clean masonry as work progresses. Allow mortar droppings on masonry to partially dry then remove by means of brushing with a stiff fibre brush.

B. Post-Construction: Clean a 10 sq. m. area of wall designated by Consultant as directed below and leave for one week. If no harmful effects appear and after mortar has set and cured, clean masonry as follows:

1. Protect windows, sills, doors, trim and other work from damage.

2. Remove large particles with wood paddles without damaging surface.

Saturate masonry with clean water and flush off loose mortar and dirt.

3. Scrub with solution of 25 mL 1 tsp. trisodium phosphate and 25 mL 1 tsp. household detergent dissolved in 1 L 4 cups of clean water using stiff fibre brushes, then clean off immediately with clean water using hose.

4. Repeat cleaning process as often as necessary to remove mortar and other stains.

C. Use alternative cleaning solutions and methods for difficult to clean masonry only after consultation with masonry unit manufacturer.

3.13 PROTECTION

- A. Protect masonry units from damage resulting from subsequent construction operations.
- B. Use protection materials and methods which will not stain or damage masonry units.
- C. Remove protection materials upon Substantial Performance of the Work, or when risk of damage is no longer present.

- - - E N D - - -