SECTION 03 01 30
MAINTENANCE OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The following processes to refurbish existing interior concrete window sills in the Dixie Building:
1. Removal of deteriorated concrete.
2. Patching.
3. Crack filling.
4. Surface coating, leveling, and smoothing.
5. Sealer.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: Cured samples for each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Material certificates.

B. Product test reports.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer to apply epoxy crack injection materials corrosion-inhibiting treatments and sealers.

1.1 APPLICABLE PUBLICATIONS (latest editions unless otherwise indicated)

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):
1. C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
2. C1028 Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
3. D624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
4. D638 Standard Test Method for Tensile Properties of Plastics

5. D2240 Standard Test Method for Rubber Property—Durometer Hardness

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain each color, grade, finish, type, and variety of product from single source with resources to provide products of consistent quality in appearance and physical properties.

B. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

2.2 PATCHING MATERIAL

A. Patching Mortar, General:
1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar that matches existing, adjacent, exposed concrete.

B. Cementitious Patching and Coating Material: Packaged, dry mix for repair of concrete; for interior and exterior use.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Ardex "TWP" or "OVP" (Contractor's option) or comparable product by one of the following:
   a. BASF Construction Chemicals - Building Systems.
   b. Ardex Engineered Cements.
   c. CGM, Incorporated.
   d. Dayton Superior Corporation.
   e. Euclid Chemical Company (The); an RPM company.
   f. Kaufman Products, Inc.
   g. Sika Corporation; Construction Product Division.
   h. Sto Corp.; Concrete Restoration Division.
2. Description: Trowelable, Portland cement-based patching and finishing compound for mixing with water; capable of a true featheredge and filling spalls, gouges, cracks, dents, chips, big holes, honeycombs, and other holes of any depth on horizontal and vertical surfaces.
3. Compressive Strength (ASTM C109): 4200 psi, minimum.

C. Color: As selected by Architect from full range of industry colors.

2.3 JOINT AND CRACK FILLER

A. Joint Filler: Two-component, polyurethane compound, 100 percent solids, for interior and exterior use.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Ardex "Ardifix" or comparable product by one of the following:
   a. BASF Construction Chemicals - Building Systems.
   b. Ardex Engineered Cements.
   c. CGM, Incorporated.
   d. Dayton Superior Corporation.
   e. Euclid Chemical Company (The); an RPM company.
   f. Kaufman Products, Inc.

g. Sika Corporation; Construction Product Division.
h. Sto Corp.; Concrete Restoration Division.

2. Physical Characteristics:
   a. Patching and finishing compound for crack filling and repair on horizontal and vertical surfaces.
   b. Tensile Strength (ASTM D638): Approx. 4150 psi (292 kg/cm2).
   c. Elongation (ASTM D638): 6 percent.
   d. Die C Tear (ASTM D624): 243 pli.
   e. Shore D Hardness (ASTM D2240): 70.
   f. Viscosity: 60 cps.
   g. VOC: 0 g/L, calculated SCAQMD 1168.

B. Color: As selected by Architect from full range of industry colors.

2.4 OTHER MATERIALS

A. Sealer: Low-viscosity, high solids, acrylic penetrating sealer recommended by manufacturer for penetrating and sealing cracks in interior and exterior concrete traffic surfaces.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Ardex "CG" or comparable product by one of the following:
      a. BASF Construction Chemicals - Building Systems.
      b. Ardex Engineered Cements.
      c. CGM, Incorporated.
      d. Dayton Superior Corporation.
      e. Euclid Chemical Company (The); an RPM company.
      f. Kaufman Products, Inc.
      g. Sika Corporation; Construction Product Division.
      h. Sto Corp.; Concrete Restoration Division.
   2. Physical Characteristics:
      a. Patching and finishing compound for crack filling and repair on horizontal and vertical surfaces.
      b. Solids Content: 40 percent.
      c. Static Coefficient of friction (ASTM C1028):
         1) Smooth surface profile: 0.60-0.70.
         2) Medium to coarse surface profile: 0.88-0.90.
      d. Solvent: Water only.
      e. USDA/FDA FSIS, Directive 1000.4, Revision 1: Approved.
      f. Stain Resistance: As follows or more resistant:
         1) Number Code Used Below (Non-Abraded / Abraded):
            a) 1 - Unaffected.
            b) 2 - Superficial effect.
            c) 3 - Considerable effect.
         2) Ammonia Solution (5 percent): 1 / 2.
         3) Chlorine Solution (10 percent): 2 / 2.
         4) Diesel Fuel: 1 / 2.
         5) Gasoline: 1 / 1.
         6) Heavy-Duty Detergent Solution: 1 / 1.
         7) Hydraulic Fluids: 3 / 3.
         8) Kerosene: 1 / 2.
         9) Lubricating Oil: 1 / 1.
         10) Muratic Acid (10 percent): 1 /1.
         11) Paint Thinner: 1 / 1.
         12) Prestone® Antifreeze Coolant: 1 / 2.
         13) Salt Solution (20 percent): 1 /1.
         14) Soap Solution (1 percent): 1 / 1.

15) Sulfuric Acid (3 percent): 2 / 3.
16) Sulfuric Acid (Concentrated): 2 / 3.
17) Toluene: 1 / 2.
18) Transformer Oil: 1 / 1.
19) Turpentine: 1 / 2.

B. Color and Sheen: As selected by Architect from full range of industry colors including clear gloss, clear matte, and concrete gray tint matte.

2.5 MIXES

A. General: Mix products, in clean containers, according to manufacturer's written instructions.

B. Dry-Pack Mortar: Mix patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Notify Architect seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

B. Locate areas of deteriorated or delaminated concrete using hammer Pounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb unless otherwise indicated.

3.2 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete maintenance work begins and during its progress.

B. Preparation for Removal of Deteriorated Concrete: Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.

C. Concrete Removal:
1. Remove deteriorated and delaminated concrete.
2. Thoroughly clean removal areas of loose concrete, dust, and debris.

D. Surface Preparation: Remove dirt, coatings, and other surface contaminants that may interfere with bond of maintenance materials. Abrade or otherwise roughen surfaces according to manufacturer's recommendations.

3.3 APPLICATION

A. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.

B. Placing Patching Material: Place as follows unless otherwise recommended in writing by manufacturer:
1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

3. Pretreatment: Apply bonding agent if and where recommended by patching material manufacturer.
4. General Placement: Place patching material by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch.
5. Finishing: Finish to a smooth trowel surface.
6. Curing: Wet-cure cementitious patching materials as recommended by manufacturer.

C. Crack: Fill / repair cracks with crack filler instead of patching material at Contractor's option.

D. Sealer: Apply by brush, roller, or airless spray at manufacturer's recommended application rate; two coats minimum.

- - - END OF SECTION - - -

SECTION 03 30 01
CAST-IN-PLACE CONCRETE (SITE STRUCTURES)

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies cast-in-place structural concrete for the following items for site work:
1. Pile caps for paving and site structures.
2. Grade beams for paving and site structures
3. Light pole bases.
4. Foundations for masonry site walls.
5. All formed site concrete with form material and finishing as specified under Section 32 13 15, Architectural Site Concrete for work indicated on the MATREIALS PLAN of Landscape Drawings.
    a. Steps
    b. Walls
6. Concrete Paving and curbs: Pavement work includes colored concrete and special finishing as specified under Section 32 13 15, Architectural Site Concrete for work indicated on the MATERIALS PLAN of Landscape Drawings.

1.2 RELATED WORK:

A. Concrete paving, curbs, and walks: Section 32 05 23, Cement and Concrete for Exterior Improvements.

B. Finishes, form materials, additives, quality control, and execution requirements for concrete paving, curbs, curb ramps, walls, steps, and water feature indicated on the MATERIALS PLAN of Landscape Drawings: Section 32 13 15, Architectural Site Concrete.

C. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

D. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT.

1.3 TOLERANCES:

A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is (+0 inch) and (±-1/8 inch).

B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 10, 13, and 16 (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 (10 feet) of construction joints and vertical elements that project through slab surface.
   2. Maximum elevation change which may occur within (10 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).
   4. ± 1/8 inch finish grade tolerance.

1.4 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.

1.5 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Shop Drawings:
   1. Reinforcing Steel
   2. Mock-ups

C. Mill Test Reports:
   1. Reinforcing Steel.
   2. Cement.

D. Manufacturer's Certificates and Product Data:
   1. Abrasive aggregate.
   2. Air-entraining admixture.
   3. Chemical admixtures, including chloride ion content.
   4. Waterproof paper for curing concrete.
   5. Liquid membrane-forming compounds for curing concrete.
   6. Non-shrinking grout.
   7. Liquid hardener.
   8. Waterstops.
   9. Expansion joint filler.
   10. Adhesive binder.

E. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians and evidence of active participation in program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology and copy of report of latest CCRL, Inspection of Laboratory.

F. Test Report for Concrete Mix Designs: Trial mixes including water-cement ratio curves, concrete mix ingredients, and admixtures.

1.6 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.

1.7 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. Methods of placing, finishing, and curing.
6. Finish criteria required to obtain required flatness and levelness.
7. Timing of floor finish measurements.
8. Material inspection and testing.

C. Attendees: Include but not limited to representatives of Contractor; subcontractors involved in supplying, conveying, placing, finishing, and curing concrete; manufacturer; admixture manufacturers; Resident Engineer; Consulting Engineer; Architect, Landscape Architect, 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.

E. See 32 13 15 for Pre-Construction Meeting.

1.8 MOCK-UP:

A. In addition to the other specified samples and tests, construct a mock-up using the materials, reinforcing, forming system and construction methods proposed for use in exposed architectural concrete.

B. Construct the mock-up with at least a 2.5 m by 2.5 m (8 feet by 8 feet) exposed surface and suitable foundations. Include the following where applicable: Control joints, reglets, recesses or other typical architectural details.

C. Before casting the mock-up, submit full detailed Shop Drawings of the mock-up formwork for review by the Architect. Perform all necessary preliminary tests to ensure that concrete used for the mock-up will exactly match the approved sample in color and texture.

D. Perform the surface treatment proposed for use on one or more areas not less than 300 mm by 300 mm (1 foot by 1 foot) on the back side of the mock-up to establish the texture of finish required by the Architect. Repeat as required until a sample satisfactory to the Architect has been obtained.

E. Treat the finished front surface of the mock-up to produce a uniform appearance similar in every respect to the approved sample area.

F. The completed mock-up shall be inspected by the Architect. Failure of the mock-up to match the approved sample will require the construction of further mock-ups until approval is obtained. Remove rejected mock-ups immediately.

G. Mock-ups are required at Architectural Site Concrete items. Refer to Section 32 13 15 – ARCHITECTURAL SITE CONCRETE.

H. Maintain the approved mock-ups in good condition at the job site until all architectural concrete surfaces have been completed and approved by the Architect. Remove the mock-up from the site after completion of the above. Accepted mock-ups can be part of completed work.

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):
117-06.....Tolerances for Concrete Construction and Materials
211.1-02.....Selecting Proportions for Normal, Heavyweight, and Mass Concrete
214R-02 .....Evaluation of Strength Test Results of Concrete
301-05.....Structural Concrete
304R-2000 .....Guide for Measuring, Mixing, Transporting, and Placing Concrete
305R-06 .....Hot Weather Concreting
306R-(2002).....Cold Weather Concreting
308R-(2001).....Standard Practice for Curing Concrete
309R-05 .....Guide for Consolidation of Concrete
31808.....Building Code Requirements for Reinforced Concrete and Commentary
347R-04 .....Guide to Formwork for Concrete
SP-66-04.....ACI Detailing Manual
303.1-97……..Standard specification for Cast-in-Place Architectural Concrete.

C. American National Standards Institute and American Hardboard Association (ANSI/AHA):
A135.4-2004 .....Basic Hardboard

D. American Society for Testing and Materials (ASTM):
A82/A82M-07.....Steel Wire, Plain, for Concrete Reinforcement
A185/185M-07 .....Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A615/A615M-08.....Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A653/A653M-07.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A706/A706M-06 ..... Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A767/A767M-05 ..... Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

A996/A996M-06 ..... Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
C31/C31M-08 ..... Making and Curing Concrete Test Specimens in the field
C33-07 ..... Concrete Aggregates
C39/C39M-05 ..... Compressive Strength of Cylindrical Concrete Specimens
C94/C94M-07 ..... Ready-Mixed Concrete
C143/C143M-05 ..... Slump of Hydraulic Cement Concrete
C150-07 ..... Portland Cement
C171-07 ..... Sheet Materials for Curing Concrete
C172-07 ..... Sampling Freshly Mixed Concrete
C173-07... ..... Air Content of Freshly Mixed Concrete by the Volumetric Method
C192/C192M-07 ..... Making and Curing Concrete Test Specimens in the Laboratory
C231-08 ..... 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
C494/C494M-08 ..... Chemical Admixtures for Concrete
C496-06 ..... Splitting Tensile Strength of Cylindrical Concrete Specimens
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-07 ..... Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
C1315-08 …… Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
D1751-04 ..... Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D4397-02 ..... Polyethylene Sheeting for Construction, Industrial and Agricultural Applications
E1155-96(R2008) ..... Determining F_F Floor Flatness and F_L Floor Levelness Numbers

E. Concrete Reinforcing Steel Institute (CRSI):

Handbook 2008

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 for Concrete Rib-Type Construction: Steel (removal type) of suitable weight and form to provide required rigidity.

D. Permanent Steel Form for Concrete Slabs: Corrugated, ASTM A653, Grade E, and Galvanized, ASTM A653, G90. Provide venting where insulating concrete fill is used.

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. APA High Density Overlay (HDO) plywood (3/4" thickness). Required for Architectural Site Concrete.

G. 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.
   1. Form ties are not permitted for exposed Architectural Site Concrete work. Refer to 32 13 15.

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 alkalis, 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. 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.

E. Mixing Water: Fresh, clean, and potable.

F. 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: Written conformance to the requirements above and the chloride ion content of the admixture prior to mix design review.
8. See 32 13 15 for required and prohibited additives for Architectural Site Concrete.
9. Waterproofing Admixture:
   a. Xypex Admix C-1000.
   b. The concrete waterproofing admixture shall be of the cementitious crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the concrete.
   c. The design shall include the use of the crystalline waterproofing repair materials that generate a non-soluble crystalline formation in the concrete.
   d. The concrete crystalline waterproofing admixture shall be specifically formulated as a concrete admixture.
   e. The dosage rate for the Xypex Admix C-1000 shall be 3% by weight of cement.
   f. Crack Bridging Capability: Requirement: Crystalline Waterproofing shall be capable of sealing static cracks up to 1/64".
10. Shrinkage Inhibiting Admixture: Shrinkage reducing admixture shall be Tetraguard manufactured by Master Builders (Basis-of-Design Product or Pre-Bid approved equal). Dosage rate shall be in accordance with manufacturer's recommendations for the designated use, but not less than 1.5 gal./yd.

G. Polyethylene sheet: ASTM D4397, (6 mil and 15 mil).

H. Reinforcing Steel: ASTM A615, or ASTM A996, deformed, grade as shown.

I. Welded Wire Fabric: ASTM A185.

J. Reinforcing Bars to be Welded: ASTM A706.

K. Galvanized Reinforcing Bars: ASTM A767.

L. Supports, Spacers, and Chairs: Types which will hold reinforcement in position shown in accordance with requirements of ACI 318 except as specified.

M. Expansion Joint Filler: ASTM D1751.

N. Sheet Materials for Curing Concrete: ASTM C171.

O. 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.

P. Abrasive Aggregate: In accordance with Section 32 13 15 – ARCHITECTURAL SITE CONCRETE REQUIREMENTS.

Q. Non-Shrink Grout:
1. ASTM C1107, pre-mixed, produce a compressive strength of at least 18 MPa at three days and 35 MPa (5000 psi) at 28 days. Furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 1200 mm x 1200 mm (4 foot by 4 foot) base plate.

2. Where high fluidity or increased placing time is required, furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent under an 450 mm x 900 mm (18 inch by 36 inch) base plate.

R. Adhesive Binder: ASTM C881.
1. Polyvinyl Chloride Waterstop: CRD C572.
2. Rubber Waterstops: CRD C513.
3. Bentonite Water Stop: Flexible strip of bentonite 25 mm x 20 mm (1 inch by 3/4 inch), weighing 8.7 kg/m (5.85 lbs. per foot) composed of Butyl Rubber Hydrocarbon (ASTM D297), Bentonite (SS-S-210-A) and Volatile Matter (ASTM D6).
4. Porous Backfill: Crushed stone or gravel graded from 25 mm to 20 mm (1 inch to 3/4 inch).
5. Synthetic Fibers: Monofilament or fibrillated polypropylene fibers for secondary reinforcing of concrete members. Use appropriate length and 0.9 kg/m^3 (1.5 lb. per cubic yard). Product shall have a UL rating.
6. Epoxy Joint Filler: Two component, 100 percent solids compound, with a minimum shore D hardness of 50.
7. Bonding Admixture: Non-rewettable, polymer modified, bonding compound.

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 m^3 (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.
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.
5. 15% Fly-ash Maximum.
6. Slag. Not acceptable.

B. 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.

C. Cement Factor: Maintain minimum cement factors in Table I regardless of compressive strength developed above minimums. Fly ash may be substituted for up to 20 percent of the minimum cement factor at option of Contractor, except fly ash may not be used in concrete designated as architectural concrete.

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)	0.50
25 (3000)[1,3]	280 (470)	0.65	290 (490)	0.55
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. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.

* Determined by Laboratory in accordance with ACI 211.1 for normal concrete or ACI 211.2 for lightweight structural concrete.

D. 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)
Slabs, Grade Beams and Reinforced Walls	100 mm (4 inches)	100 mm (4 inches)

* 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.

E. Air-Entrainment: Air-entrainment of normal weight concrete shall be 2 to 4 percent.. Determine air content by either ASTM C173 or ASTM C231.

F. 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.

G. 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 fiber 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).

H. Durability: Use air entrainment for exterior exposed concrete subjected to freezing and thawing and other concrete shown or specified. Air content as shown in Table III or Table IV.

I. 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 38^0C (100 degrees Fahrenheit). Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
-1. 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, shores, and reshores.
   1. 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.
   2. Provide forms for concrete footings unless Resident Engineer determines forms are not necessary.
   3. 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 screwed to studs with all edges in close contact to prevent bulging of lining. No joints in lining and backing may coincide. Screw 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. Fill and sand screw heads with appropriate filler to achieve smooth surface.

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.
   3. Ties not permitted for exposed Architectural Site Concrete. See 32 13 15.

G. Inserts, Sleeves, and Similar Items: Steel strips, anchors, wood blocks, nailing strips, grounds, inserts, wire hangers, sleeves, drains, guard angles, 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. Do not install sleeves in grade beams, walls, or pile caps except where shown or permitted by Resident Engineer. Install sleeves in beams, joists, or columns that are not shown, but are permitted by the Resident Engineer, and require no structural changes, at no additional cost to the Government.
   3. 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.
   4. Provide recesses and blockouts in slabs and walls as indicated.

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 and ACI 315, 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 315. 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.
   2. Lap welded wire fabric at least 1 1/2 mesh panels plus end extension of wires not less than 300 mm (12 inches) in structural slabs. Lap welded wire fabric at least 1/2 mesh panels plus end extension of wires not less than 150 mm (6 inches) in slabs on grade.
   3. Splice column steel at no points other than at footings and floor levels unless otherwise shown.

C. Spacing: Minimum clear distances between parallel bars, except in columns and 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 POLYETHYLENE SHEET:

A. Exterior pile supported concrete slabs shall be placed on a continuous polyethylene sheet.
   1. Joints lapped 150 mm (6 inches) and sealed with compatible waterproof pressure-sensitive tape.
   2. Patch punctures and tears.

3.4 EXPANSION JOINTS:

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

3.5 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.

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.

3.6 HOT WEATHER:

A. 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.

3.7 COLD WEATHER:

A. 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.

3.8 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 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 $10m^2/L$ (400 square feet per gallon) on steel troweled surfaces and $7.5m^2/L$ (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. Paper: Utilize widest practical width paper and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic or glue.

3.9 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.

3.10 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.

3.11 CONCRETE FINISHES:

A. Vertical 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 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 µm (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.

3. Textured: Finish as specified. Maximum quantity of patched area 0.2 m^2 (2 square feet) in each 93 m^2 (1000 square feet) of textured surface.

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 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 dimensioned 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 steel trowel finish, fill, or mortar setting beds, and ramps, stair treads, platforms 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. Remove any surface projections and re-float to a uniform texture.

9. Broom Finish: Finish transformer pad slab with a bristle brush moistened with clear water after surfaces have been floated. Match texture approved by Resident Engineer from sample panel.
10. Architectural Site Concrete: Exterior slabs to be steel troweled with a light sand blast finish in accordance with Section 32 13 15 – ARCHITECTURAL SITE CONCRETE.
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:
       Slab on Grade:
       Specified overall value F_F 25/F_L 20
       Minimum local value F_F 17/F_L 15
       Level suspended slabs (shored until after testing) and topping slabs:
       Specified overall value FF 25/FL 20
       Minimum local value FF 17/FL 15
       Unshored suspended slabs:
       Specified overall value FF 25
       Minimum local value FF 17
       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:
       Slab on grade:
       Specified overall value FF 36/FL 20
       Minimum local value FF 24/FL 15
       Level suspended slabs (shored until after testing) and topping slabs
       Specified overall value FF 30/FL 20
       Minimum local value FF 24/FL 15
       Unshored suspended slabs:
       Specified overall value FF 30
       Minimum local value FF 24
       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 F_F, F_L, 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 insure 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 F_F and F_L 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.

3.12 SURFACE TREATMENTS:

A. Liquid Densifier/Sealer: Apply in accordance with manufacturer's directions just prior to completion of construction.

B. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of exterior 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.

- - - E N D - - -

SECTION 03 30 09
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION:

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

B. Basic Specification: Perform work of this Section according to ACI 301-05, "Specifications for Structural Concrete," except as specifically modified herein. Numbers in parentheses (0.00) indicate a related paragraph of ACI 301.

C. Section Includes: All cast-in-place concrete shown on the Drawings and required by these Specifications. Allow for the installation of cast-in-place items furnished under other Sections. Install anchor bolts for structural steel. Provide and install grout under steel column base plates and beam bearing areas.

D. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.

E. Provide concrete pads, piers, curbs, and bases required for equipment of all trades. Coordinate dimensions and details with requirements of equipment being supplied, prior to placing concrete.

F. Coordinate the work of other trades who will provide and install items (sleeves, piping, conduit, inserts, etc.) to be cast in the concrete. Place no concrete until all such items are in place.

G. Architectural concrete at locations designated on the Drawings.

1.2 RELATED WORK:

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Structural Steel: Section 05 12 00, STRUCTURAL STEEL.

C. Floor Deck: Section 05 36 00, COMPOSITE METAL DECKING.

1.3 TESTING AGENCY FOR CONCRETE MIX DESIGN:

A. Testing agency for concrete mix designs shall be 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. Accompany request for approval of testing agency with a copy of Report of Latest Inspection of Laboratory Facilities by CCRL.

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 inch and -3/4 inch.

B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 3, 4, and 5 (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 inch and -1/2 inch where gross bar length is less than 12 feet, or +0 inch and -3/4 inch where gross bar length is 12 feet or more.

C. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +3/4 inch and -1/4 inch. Tolerance of thickness of beams more than 12 inch but less than 3 feet is +3/4 inch and -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 2 feet of construction joints and vertical elements that project through slab surface.
2. Maximum elevation change which may occur within 2 feet of any column or wall element is 0.25 inches.
3. Allow sample measurement lines that are perpendicular to construction joints to extend past joint into previous placement no further than 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.

D. ACI 117-06 Specifications for Tolerances for Concrete Construction and Materials.

E. CRSI "Placing Reinforcing Bars," 2006, 8th Edition.

F. WRI "Manual of Standard Practice," July 2001, 6th Edition.

1.6 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Samples:

1. Portland cement: 8 pounds.
2. Fly ash: 5 pounds.

C. Shop Drawings:

1. Reinforcing steel: Complete shop drawings

D. Mill Test Reports:

1. Reinforcing Steel.
2. Cement.

E. Manufacturer's Certificates:

1. Lightweight aggregate for structural concrete.
2. Air-entraining admixture.
3. Chemical admixtures, including chloride ion content.
4. Waterproof paper for curing concrete.
5. Non-shrinking grout.
6. Adhesive binder.

F. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians and evidence of active participation in program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology and copy of report of latest CCRL, Inspection of Laboratory.

G. Submit a mix design for each class of concrete required (1.6.3.2.e). Submittals to comply with appropriate methods listed in ACI 301-05 (4.2.3). Indicate whether mixes have been designed for pumping.

H. Submit shop drawings for all reinforcing. Indicate strength, size, and details of all bar reinforcing, and style and specification of all welded wire fabric (3.1.1).

I. Architectural Concrete:

1. Samples: Show appearance of color and texture; obtain approval of proposed mix and finish before proceeding with job mockup; make samples, not less than 12 inches square.
2. Formwork: Submit shop drawings for fabrication and erection of all architectural concrete work and exterior exposed surfaces of normal concrete work. Show general construction of forms including jointing, special form joint or rustifications, location and pattern of form tie placement, and other items which affect exposed concrete visually.
   a. Architect's review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor's responsibility.
   b. Submit sample smooth forms for approval of surface characteristics; minimize size 2 feet x 2 feet. Sample to be representative of material used for construction.

1.7 QUALITY ASSURANCE

A. Architectural Concrete: Areas designated on the drawings as Architectural Concrete shall meet the requirements of this Section and the following requirements. Where requirements conflict comply with the more stringent requirement.

1. Architectural concrete shall include the areas exposed concrete designated on the drawings as architectural concrete and continue 12 inches below finished grade.
2. Job Mockup: After approval of samples and before starting work, build mock-up on site for approval. Build mock-up on firm foundation in location as directed by Architect. Mockup will be included as part of the mockup specified for WP-6.
   a. Show wall corner and any special shape conditions(s), minimum 10 feet long by 4 feet high with not less than 4 foot corner return; minimum thickness 8 inches.
   b. Mock-up to show the following:
      1) Vertical butt form joint.
      2) Workmanship at exterior corners.
      3) Form tie-hole treatment.
      4) Finish/texture/color of approved samples.
   c. After approval, mock-up will be used as a standard for approval of subsequent architectural concrete work.
3. Comply with the following requirements in ACI 301:
   a. Finishing formed surfaces (5.3.3) and Surface finish (5.3.3.c).
   b. Rubbed finishes (5.3.3.4) and Grout-cleaned rubbed finish (5.3.3.4.b).
   c. Curing and protection (5.3.6) and Formed concrete surfaces (5.3.6.3). Use of curing compounds is not permitted.
   d. Repair of surface defects (5.3.7.2) and Repair of surface defects other than tie holes (5.3.7.3).
   e. Reinforcement, reinforcement supports, spacers and tie wires (6.2.1.7).
   f. Form Ties (6.2.1.9).
   g. Form-release agents (6.2.1.11).
   h. Formwork (6.2.2.1) and provide formwork with ACI 117 tolerances with a Class A-class of Surface. Surfaces produced shall require only minor dressing to arrive at true surfaces.
   i. Preparation (6.3.1).
   j. Placement of reinforcement (6.3.2.

k. Formwork removal (6.3.8).
l. Repair of tie holes and surface Defects (6.3.9), Repair area (6.3.9.2), Color and texture match (6.3.9.3), Curing Repairs (6.3.9.5).
m. Curing Architectural Concrete (6.3.11).

4. Note: Architectural Concrete will receive a penetrating sealer as part of EWP-6. Do not apply materials that will not permit the proper application of the concrete penetrating sealer.

1.8 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 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.

1.9 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. Methods of placing, finishing, and curing.
6. Finish criteria required to obtain required flatness and levelness.
7. Timing of floor finish measurements.
8. 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; Construction Manager 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.

1.10 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):
117-06 ..... Tolerances for Concrete Construction and Materials
211.1-02 ..... Selecting Proportions for Normal, Heavyweight, and Mass Concrete
211.2-04 ..... Selecting Proportions for Structural Lightweight Concrete
214R-02 ..... Evaluation of Strength Test Results of Concrete
301-05 ..... Structural Concrete
304R-2000 ..... Guide for Measuring, Mixing, Transporting, and Placing Concrete
305R-06 ..... Hot Weather Concreting
306R-(2002)..... Cold Weather Concreting
308R-(2001)..... Standard Practice for Curing Concrete
309R-05 ..... Guide for Consolidation of Concrete
318-08 ..... Building Code Requirements for Reinforced Concrete and Commentary
347R-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):
A82/A82M-07..... Steel Wire, Plain, for Concrete Reinforcement
A185/185M-07..... Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A615/A615M-08..... Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A653/A653M-07..... Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
A706/A706M-06..... Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A996/A996M-06..... Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
C31/C31M-08 ..... Making and Curing Concrete Test Specimens in the field
C33-07 ..... Concrete Aggregates
C39/C39M-05 ..... Compressive Strength of Cylindrical Concrete Specimens
C94/C94M-07 ..... Ready-Mixed Concrete
C143/C143M-05 ..... Slump of Hydraulic Cement Concrete
C150-07 ..... Portland Cement
C171-07 ..... Sheet Materials for Curing Concrete
C172-07 ..... Sampling Freshly Mixed Concrete
C173-07... ..... Air Content of Freshly Mixed Concrete by the Volumetric Method
C192/C192M-07 ..... Making and Curing Concrete Test Specimens in the Laboratory

C231-08 .....Air Content of Freshly Mixed Concrete by the Pressure Method
C260-06 .....Air-Entraining Admixtures for Concrete
C330-05 .....Lightweight Aggregates for Structural Concrete
C494/C494M-08 .....Chemical Admixtures for Concrete
C567-05 .....Density of Structural Lightweight Concrete
C618-05 .....Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
C881/C881M-02 .....Epoxy-Resin-Base Bonding Systems for Concrete
C1107/1107M-07.....Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
D4397-02 .....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):
D1.4-05 .....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

1.11 LEED SUBMITTALS

A. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

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) 5/8 inch, or 3/4 inch thick for unlined contact form. B-B High Density Concrete Form Overlay optional.

C. Form Lining:

1. Hardboard: ANSI/AHA A135.4, Class 2 with one (S1S) smooth side)
2. Plywood: Grade B-B Exterior (concrete-form) not less than 1/4 inch thick.
3. Plastic, fiberglass, or elastomeric capable of reproducing the desired pattern or texture.

D. Form Ties: Develop a minimum working strength of 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 3/4 inch diameter, or a depression in exposed concrete surface, or leave metal closer than 1 1/2 inches to concrete surface. Wire ties not permitted. Cutting ties back from concrete face not permitted.

E. Dovetail Slots: Galvanized steel, 24 gauge, minimum.

F. Preformed Adhesive Waterstop: Conform to Federal Specification SSS-210. Acceptable products include but are not limited to:

1. Conseal CS-235 by Concrete Sealants, Inc.
2. HF302 Hydro-Flex by Henry Company
3. Swell Stop by Greenstreak Group, Inc.

G. Performed Expansion Joint Filler: ASTM D1751-04(2008). Acceptable products include, but are not limited to:

1. Fibre or Ceramar by W.R. Meadows
2. A.P.S. Fiber Board by A.P.S.
3. Fiber XJ by Iko

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. Ground Granulated Blast Furnace Slag (GGBF): ASTM C989-06, Grade 100 or higher (see 2.4 MASS CONCRETE).

D. Coarse Aggregate: ASTM C33.

1. Size 67, Size 57, or Size 467 may be used for footings and walls over 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.

E. Lightweight Aggregates for Structural Concrete: ASTM C330, Table 1. Maximum size of aggregate not larger than one-fifth of narrowest dimension between forms, one-third of depth of slabs, nor three-fourth of minimum clear distance between reinforcing bars. Contractor to furnish certified report to verify that aggregate is sound and durable.

F. Fine Aggregate: ASTM C33. Fine aggregate for applied concrete floor topping shall pass a No. 4 sieve, 10 percent maximum shall pass a No. 100 sieve.

G. Mixing Water: Fresh, clean, and potable.

H. 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: Written conformance to the requirements above and the chloride ion content of the admixture prior to mix design review.

I. Reinforcing Steel: ASTM A615, or ASTM A996, deformed, grade as shown.

J. Welded Wire Fabric: ASTM A185.

K. Reinforcing Bars to be Welded: ASTM A706.

L. Supports, Spacers, and Chairs: Types which will hold reinforcement in position shown in accordance with requirements of ACI 318 except as specified.

M. Sheet Materials for Curing Concrete: ASTM C171.

N. Non-Shrink Grout:

1. ASTM C1107, pre-mixed, produce a compressive strength of at least 2500 psi at three days and 5000 psi at 28 days. Furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 4 foot by 4 foot base plate.
2. Where high fluidity or increased placing time is required, furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent under an 18 inch by 36 inch base plate.

O. Adhesive Binder: ASTM C881.

1. Porous Backfill: Crushed stone or gravel graded from 1 inch to 3/4 inch.
2. Synthetic Fibers: Monofilament or fibrillated polypropylene fibers for secondary reinforcing of concrete members. Use appropriate length and 1.5 lb. per cubic yard. Product shall have a UL rating.
3. Epoxy Joint Filler: Two component, 100 percent solids compound, with a minimum shore D hardness of 50.
4. Bonding Admixture: Non-rewettable, polymer modified, bonding compound.

P. Joint Sealant: Use 1-component polyurethane, conforming to ASTM C920-08, Type S, Grade NS, Class 25. Use with backer rod as required. Acceptable products include, but are not limited to:

1. Eucolastic I by Euclid.
2. Sikaflex-la by Sika.
3. Dymonic by Tremco.

Q. Sealer: Clear membrane-forming compound which will not yellow. Must be formulated for the intended application, either interior or exterior and applied per the manufacturer's written recommendations. Must comply with EPA VOC requirements and be compatible with the curing compound used.

R. Synthetic Fiber Reinforcement: ASTM C1116/C1116M-08a. Acceptable products include, but are not limited to:

1. Nycon Nylon RC Fibers by Nycon
2. Nylo-Mono Nylon Fibers or Mighty-Mono Polypropylene Fibers by Forta
3. Fibermesh 150 Polypropylene Microfibers by Grace
4. Polypropylene Fibers or Polypropylene Microfibers by Grace
5. Fiberstrand 150 or Fiberstrand 150 ML by Euclid
6. Fibrasol or Fibrasol IIP by Axim

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 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 - five pounds.
2. Portland cement - 8 pounds:
   Address -Waterways Experiment Station (WES)
   3909 Halls Ferry Road
   Vicksburg, MS 39180-6199
   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. Fly ash may be substituted for up to 20 percent of the minimum cement factor at option of Contractor, except fly ash may not be used in concrete designated as architectural concrete.

TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE

Concrete Strength (psi)	Non-Air Entrained	
	Min. Cement (lbs/yd^3)	Max. W/C Ratio
3500	510	0.60
4000	550	0.55

1. If trial mixes are used, the proposed mix design shall achieve a compressive strength 1200 psi in excess of f'c. For concrete strengths above 5000 psi, the proposed mix design shall achieve a compressive strength 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.

* 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
Slabs, Beams, and Reinforced Walls	4 inches	4 inches

* 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 9 inches. The concrete shall arrive at the job site at a slump of 2 inches to 3 inches, and 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.

F. 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.

TOTAL AIR CONTENT FOR VARIOUS SIZES OF COURSE AGGREGATES
TABLE III (NORMAL WEIGHT CONCRETE)

NOMINAL MAXIMUM SIZE OF COURSE AGGREGATE	TOTAL AIR CONTENT (% BY VOLUME)
3/8 inch	6 to 10
1/2 inch	5 to 9
3/4 inch	4 to 8
1 inch	3 1/2 to 6 1/2
1 1/2 inch	3 to 6

TABLE IV (LIGHTWEIGHT STRUCTURAL CONCRETE)

NOMINAL MAXIMUM SIZE OF COURSE AGGREGATE	TOTAL AIR CONTENT (% BY VOLUME)
Greater than 3/8 inch	4 to 8
3/8 inch or less	5 to 9

G. 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.

H. Lightweight structural concrete shall not weigh more than air-dry unit weight of 120 pcf. Air-dry unit weight determined on 6 inch by 12 inch test cylinders after seven days standard moist curing followed by 21 days drying at 23 degrees C ± 1.7 degrees C (73.4 ± 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.

I. 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 fiber 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).

J. Durability: Use air entrainment for exterior exposed concrete subjected to freezing and thawing and other concrete shown or specified. Air content as shown in Table III or Table IV.

K. 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 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 MASS CONCRETE

A. All pile caps shall be considered mass concrete.

B. Use any combination of Ground Granulated Blast Furnace Slag or Class F fly ash. Class C fly ash may also be used with a maximum substitution of 35%. The maximum total substitution of Portland cement shall not exceed 50%, including the amount in the blended cement.

C. Total cementitious content shall be a minimum of 500 pounds per cubic yard.

D. Maximum water to cementitious ratio shall be 0.45.

E. Air entrainment may be used. To improve workability and aid in air entrainment, water reducing or retarding admixtures may be used. A mid range water reducing admixture may be used and the slump shall be increased to 8 inches maximum.

2.5 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 100 degrees Fahrenheit, except maximum delivery temperature of mass concrete (pile caps) is 90 degrees Fahrenheit. Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
30 degrees to 40 degrees F	60 degrees F
0 degrees to 30 degrees F	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 ERECTION

A. This structure is designed to be self-supporting and stable after the building is fully completed. It is solely the Contractor's responsibility to determine erection procedures and sequence, and to ensure the stability of the building and its component parts, and the adequacy of temporary or incomplete connections, during erection. This includes the addition of any shoring, sheeting, temporary guys, bracing or tie-downs that might be necessary. Such material is not shown on the Drawings. If applied, they shall be removed as conditions permit, and shall remain the Contractor's property.

3.2 SURFACE CONDITIONS

A. Verify that excavations are free of water and ice, are of the required dimensions, and have been approved by the testing agency responsible for soils inspection, prior to placing concrete (5.3.1).

B. Determine field conditions by actual measurement.

C. Notify the Resident Engineer not less than 24 hours in advance of placing concrete. Place concrete only when the Architect is present, unless this requirement is specifically waived.

D. Prior to application of sealer, remove any synthetic fiber reinforcement projecting above the top surface of slabs which remain exposed.

3.3 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.

1. 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.
2. 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 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. Architectural Liner: Attach liner as recommended by the manufacturer with tight joints to prevent leakage.

G. 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 6 inches above each construction joint. Space through-ties adjacent to horizontal and vertical construction joints not over 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.

H. Removal of Forms and Shoring:

1. Remove no forms within first 24 hours after placement.
2. When structure is to be reshored, forms may be removed when the concrete attains 75% of its design strength.
3. Shoring is to remain in place until concrete reaches its design strength.
4. Remove all shoring prior to constructing masonry walls supported by the structure.

I. Welding of reinforcing shall conform to AWS D1.4/1.4M:2005 (3.2.2.2).

J. Inserts, Sleeves, and Similar Items: Flashing reglets, steel strips, masonry ties, anchors, wood blocks, nailing strips, grounds, inserts, wire hangers, sleeves, drains, guard angles, 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. Do not install sleeves in beams, joists or columns except where shown or permitted by Resident Engineer. Install sleeves in beams, joists, or columns that are not shown, but are permitted by the Resident Engineer, and require no structural changes, at no additional cost to the Government.
3. Install embedded conduit, pipes, sleeves and anchor bolts subject to the following limitations:
   a. Do not embed aluminum without prior approval of coating material.
   b. Do not displace reinforcing steel.
   c. In slabs and walls, limit outside dimension of conduits and pipes to 1/3 member thickness. Where conduits cross, maintain same minimum concrete cover as required for reinforcing bars. For slabs over metal decks, thickness is measured from the top of the metal deck.

d. In columns, limit total area of pipes and conduit to 4% of column area.
e. Maintain a center-to-center spacing of at least 3 diameters of conduit, pipe or sleeve.
f. Install anchor bolts for base plates of steel elements according to tolerances of AISC Code of Standard Practice for Steel Buildings and Bridges, March 18, 2005, Paragraph 7.5.

K. 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.

3.4 PLACING REINFORCEMENT:

A. General: Details of concrete reinforcement in accordance with ACI 318 and ACI 315, unless otherwise shown.

B. All reinforcing and welded wire fabric shall be supported on chairs.

C. Placing: Place reinforcement conforming to CRSI DA4, unless otherwise shown.

1. Place reinforcing bars accurately and tie securely at intersections and splices with 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 315. 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.
2. Lap welded wire fabric at least 1 1/2 mesh panels plus end extension of wires not less than 12 inches.

D. Spacing: Minimum clear distances between parallel bars, except in columns and multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 1 inch or 1-1/3 times maximum size of coarse aggregate.

E. 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 11. Minimum lengths of lap as shown.
2. Mechanical Splices: Mechanical or welded splices conforming to the requirements of ACI 318-05 Article 12.14.3 shall be acceptable provided their installation does not compromise compliance to the Code requirements for concrete clear cover (cover to coupler must be the same as that required for rebar).

F. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by Resident Engineer.

G. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce bond.

3.5 CONSTRUCTION JOINTS:

A. Unless otherwise shown, location of construction joints to limit individual placement shall not exceed 80 feet in any horizontal direction. Allow 48 hours to elapse between pouring adjacent sections unless this requirement is waived by Resident Engineer.

B. Locate construction joints in suspended floors near the mid-point of spans for slabs, beams or girders, unless a beam intersects a girder at center, in which case joint in girder shall be offset a distance equal to twice width of beam. Provide keys and inclined dowels as shown. Provide longitudinal keys 1 1/2 inch deep x 1/3 member depth.

3.6 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.

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 10 feet for concrete containing the high-range water-reducing admixture (superplasticizer) or 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 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 its initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
6. 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 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.

3.7 MASS CONCRETE

A. Contractor shall establish procedures to control the heat of hydration developed in the mass concrete. These procedures may include, but are not limited to, the following:

1. Cooling component materials prior to addition to the mix to reduce the temperature of the concrete while in its plastic state.
2. Adding ice to the mix water.
3. Sprinkle coarse aggregate with water or wet the stockpile.

4. Insulating the forms and the surface of the concrete to prevent temperature differential.
5. Placing concrete at times of day when the ambient temperature is lowest (in summer) or highest (in winter).
6. Other acceptable methods that may be developed by the Contractor and approved in writing by the Engineer.

B. Concrete Temperature Limits: Maximum concrete temperature at time of placement shall not exceed 90 degrees F and shall not be less than 40 degrees F. The maximum concrete temperature during the period of heat dissipation shall not exceed 160 degrees F. Temperature monitoring shall be maintained until the temperature of the interior is within 50 degrees F of the average outside air temperature. The average outside air temperature shall be determined by averaging the daily high and low temperatures over the preceding seven calendar days.

C. At beginning of construction, one temperature sensor shall be installed in the first pile cap of each size placed. Temperature sensor shall be located in the center of the concrete placement. Temperatures shall be electronically recorded automatically by an approved recorder furnished by the Contractor and shall be capable of continuously recording a minimum of one reading per hour for the duration of the mass concrete temperature monitoring period. Sensors and recorder shall be accurate to within ±2 degrees F in the temperature range of 32 degrees F to 212 degrees F.

D. If maximum concrete temperature exceeds 160 degrees F in any of the pile caps monitored, immediate corrective action as recommended by the Contractor and approved by the Resident Engineer shall be taken and temperature monitoring continued until acceptable procedures are in place.

E. Additional temperature monitoring during the course of construction may be required by the Resident Engineer. If this monitoring shows the concrete temperature to be within acceptable limits, the testing will be paid for by the Owner. Otherwise, the testing will be paid for by the Contractor.

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, thiocyantes 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 not covered with membrane 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.

1. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 2 inches. Tightly seal joints with tape.
2. Paper: Utilize widest practical width paper and overlap adjacent sheets 2 inches. Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic or glue.

3.11 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 1 inch. Cut edge perpendicular to surface of concrete. Saturate with water area to be patched, and at least 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.

3.12 CONCRETE FINISHES:

A. Vertical and Overhead Surface Finishes:

1. ~~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.
RFI 6959 Exposed structures will not be painted. See RFI 6959 for clarification of exposed concrete finishing.

2. 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 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.
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 monolithically. Once slab placement commences, complete finishing operations within same day. Slope finished slab to floor drains where they occur, all occurrences are indicated on architectural plans RFI 06513
4. Use straightedges specifically made for screeding, such as hollow magnesium straightedges or power strike-offs. Do not use pieces of dimensioned 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 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 1/4 inch indentation.

7. Float Finish: Slabs to receive unbonded toppings, steel trowel finish, fill, mortar setting beds, or a built-up roof, 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 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.
8. Steel Trowel Finish: Concrete surfaces to receive resilient floor covering or carpet, monolithic floor slabs to be exposed to view in finished work 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.
9. Finished slab flatness (F_F) and levelness (F_L) values comply with the following minimum requirements:
    a. Slab on Grade **(including Level 1) and Shored Suspended Slabs**:

Specified overall value	F_F 25/F_L 20
Minimum local value	F_F 18/F_L 13
Unshored suspended slabs:	
Specified overall value	F_F 25
Minimum local value	F_F 18

    Level tolerance such that 80 percent of all points fall within a 3/4 inch envelope +3/8 inch, -3/8 inch from the design elevation.
    b. "Specified overall value" is based on the composite of all measured values in a placement derived in accordance with ASTM E1155.
    c. "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.
10. Measurements
    a. Department of Veterans Affairs retained testing laboratory will take measurements as directed by Resident Engineer, to verify compliance with F_F, F_L, 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 insure 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 F_F and F_L 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.

11. 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.
12. 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.

3.13 SURFACE TREATMENTS:

A. Use on exposed concrete floors and concrete floors to receive carpeting.

B. Liquid Densifier/Sealer: Apply in accordance with manufacturer's directions just prior to completion of construction.

END OF SECTION

SECTION 03 45 00
PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section Includes:

1. 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.
2. Architectural precast concrete wall panels.
3. Insulated architectural precast concrete wall panels.
4. Galvanized steel connection hardware.
5. Structural design of panels and attachments.
6. Firestopping between edge of slab, edge of rated roofs, and Precast Architectural Concrete cladding conditions.
7. Removable precast architectural concrete panels, for equipment access, at locations indicated.Structural steel supports for precast architectural concrete that is not included in WP-5.
8. Work of this section includes, but not limited to, precast designated on the drawings as types PC-1.
9. Design.

B. Products Furnished but not Installed Under this Section:
1. Embedded items in the cast in place concrete. Embedded items in the cast in place concrete shall be installed by trade contractor designated by Construction Manager.

C. Products Installed but not Furnished Under this Section:
1. Embedded items for support of glazed framing systems. Furnished by Section 08 44 13 - Glazed Aluminum Curtain Walls.
2. Stainless Steel Reglets for flashing: Not applicable. Flashing shall be surface mounted to face of precast panels.

D. Work Specified Elsewhere, but Provided Under this Section:

1. Work of this Section shall comply with Section 03 45 00.30 – Blast Resistant Requirements for Precast Architectural Concrete, Life Safety Buildings.
2. Work of this Section shall comply with Section 03 45 00.50 – Blast Resistant Requirements for Precast Architectural Concrete, Mission Critical Rated Buildings.
3. Structural steel supports for precast architectural concrete that is not included in WP-5: Provide in conformance with Section 05 50 00- Metal Fabrications.

1.2 RELATED WORK (Items not included in this Project Manual are available from the Construction Manager upon request)

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Mockup: Section 01 43 39 – Mockups.

C. Exterior Wind Enclosure Requirements: Section 01 83 16.13.

D. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE: See Construction Manager. Section was issued with EWP-5.

E. Section 04 05 16, Masonry Grouting

F. Hot Dip Galvanizing: Section 05 05 15.

G. Metal Fabrications: Section 05 50 00.

H. Water repellent treatment (Alternate): Section 07 19 16, Silane Water Repellents.

I. Spray insulation: Section 07 21 29 - Sprayed Polyurethane Foam Insulation & Air/Vapor Barrier System.

J. Metal Coping at Precast Architectural Concrete: Section 07 72 00 - Roof Accessories.

K. Flashing and Sheet Metal: Section 07 60 00.

L. Firestopping at edge of slab: Section 07 84 00 - Firestopping

M. Sealants and Caulking: Section 07 92 00, JOINT SEALANTS.

N. Size, type and color of aggregate for exposed aggregate finish and matrix color: Section 09 06 00, Schedule for Finishes.

O. Glazed Aluminum Curtain Walls: Section 08 44 13.

1.3 DEFINITIONS

A. "Precast Architectural Concrete", "precast architectural concrete", "Architectural Precast Concrete", and "architectural precast concrete" are interchangeable terms for purposes of this contract.

1.4 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 for at least 10 years:

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 work.

4. Precast Architectural Concrete shall be fabricated to meet or exceed above requirements and construction documents. The fabricator shall be responsible for the erection of the architectural precast concrete.

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 A (Architectural Systems) for non-load-bearing members.
2. Regularly engaged for at least 5 years in erection of architectural precast concrete units similar to those required on this project.

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. Standards: Fabricator to manufacture and install architectural precast concrete to meet requirements of ACI 318.

E. Qualifications of Welders and Tackers: Certified in accordance with AWS D1.1/D.1.1M, "Structural Welding Code - Steel"; and AWS D1.4 "Structural Welding Code - Reinforcing Steel" as applicable.

F. Sample Panels: After sample approval and before fabricating units, produce a minimum of two sample panels approximately 16 sq. ft. in size for review by Resident Engineer. Incorporate full scale details of architectural features, finishes, textures, and transitions in the sample panels. Approved sample panel may be used for mockup and range sample.

1. Locate panels where indicated or, if not indicated, as directed by Resident Engineer.
2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes. Level of damage to the surface shall not exceed minor chipping, or blemishes contractor can repair in field to satisfaction of Architect.
3. After acceptance of repair technique, maintain one sample panel at the manufacturer's plant and one at the project site in an undisturbed condition as a standard for judging the completed work.
4. When back face of precast concrete unit is to be exposed, show samples of the workmanship, color, and texture of the backup concrete as well as the facing.
5. Demolish and remove sample panels only when directed.

G. Range Samples: After sample panel approval and before production of units, produce a minimum of three samples, approximately 16 sq. ft. in size, representing anticipated range of color and texture on project's units. Following range sample acceptance by the Resident Engineer, maintain samples at the manufacturer's plant as color and texture acceptability reference.

H. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Louisiana and who has a minimum of 10 years experience providing engineering services of the kind indicated for precast architectural concrete.

Professional Engineer Must Be From Louisiana Per RFI 5276

I. 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 including glass, aluminum framing, sealants and architectural precast concrete complete

with all anchors, connections, flashings, and joint fillers as accepted on the final SUBMITTALS. Build mockups to comply with the following requirements, using materials indicated for the completed work. The mock-ups are required as an Aesthetic Mockup and Testing Mockup.:

1. Aesthetic Mockup: See Section 01 43 39, Mock-Ups. Approval of aesthetic mock-up required before design of testing mock-up can proceed.
2. Testing Mockup: See Section 01 43 39, Mock-Ups. Test aesthetic Mockup.
3. Demolish and remove mockups when directed.

J. Verify water repellent treatment, specified elsewhere under Division 7, will not be detrimental to work of this Section when installed either before or after sealant joints are completed.
   1. Water repellent is specified as an Alternate.
   2. Obtain data for actual proposed material from Construction Manager.

K. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01, GENERAL REQUIREMENTS.

1.5 DESIGN REQUIREMENTS

A. The Drawings show aesthetic design intent. Products provided must conform to design intent shown and performance levels specified. The drawings and specifications are complementary regarding the aesthetic design intent.

B. Delegated Design: Design precast architectural concrete assembly, including comprehensive engineering analysis by a qualified Professional Engineer, using performance requirements, blast requirements, and design criteria indicated.

C. Structural steel supports for precast architectural concrete that is not included in WP-5: Design to meet PERFORMANCE REQUIREMENTS and allow for deflection of floor slabs.

D. Equipment Access Panels: Area of precast architectural concrete wall designated on drawing shall be designed to allow temporary removal of precast concrete panels to provide opening for MEP equipment to be transported into and out of the building. Design this feature to allow removal and re-installation of precast concrete wall panel system without modifications to precast concrete panel system to its original condition, prior to removal by Owner.
   1. Owner shall use a qualified precast architectural concrete contractor to remove and reinstall the precast architectural concrete wall components.

E. Coping: Coordinate transition from top of wall system with work of Section 07 72 00 - Roof Accessories and adjacent roofing system.

F. The Architectural drawings show precast concrete panels that have been coordinated with the building structure supporting the precast concrete panels. Increasing the thickness of concrete within a panel that require modifications to the building structure or modify Architectural design intent is not permitted unless approved by Architect and Structural Engineer. Any costs involved by contractor proposed revision(s) shall be borne by contractor. Modifying the visible profile of panels is not permitted, unless approved by Architect in writing.

1.6 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. Live Loads:
   a. Wind Load: As specified in Section 01 83 16.13 - Exterior Wind Enclosure Requirements.
   b. Blast Load: As specified in BLAST REQUIREMENTS below.
3. Limit deflection of precast members as follows:

   a. Vertical live load – Span / 360.
   b. Wind load – Floor to floor height times 0.0025.

4. Design for handling, transportation and erection stresses.

5. Punched Openings and Ribbon Type Windows: Precast Architectural Concrete shall be designed to carry live and dead loads from adjacent system.

6. Parapets: Cold formed metal framing is not designed to accept loads from precast concrete. Cold formed metal framing may be braced to precast concrete.

B. The insulated concrete sandwich panels must be constructed to maintain the effective acceptable material R value of the panels with less than one (1) percent reduction due to penetrations and connection detailing; exclusive of knife plates needed to meet blast requirements. The reduction in thermal performance must be calculated using the Isothermal planes method of R-value calculation.

   1. Assemble Maximum U-value: Not more than 0.125 BTU/(h °F ft²).

   2. Rigid insulation shall be installed in a manner to create a vapor retarder. Seal joints in and penetrations through rigid insulation to maintain its vapor retarder characteristics.

   3. Steel Connections to Building Structure: Where knife plates act as wythe connectors and penetrate the interior face of panel; insulate the knife plate and steel connection material in contact with the knife plate. Insulation shall be close cell spray foam insulation with thermal barrier as specified in Section 07 21 29 - Sprayed Polyurethane Foam Insulation & Air/Vapor Barrier System.
      a. Insulation Thickness: 1”.

C. Vapor Retarder: Insulated concrete sandwich panels shall have a perm rate of less than 1 perm, ASTM E96.

D. The insulated concrete sandwich panels must be adequately designed and constructed to prevent the growth of mold and mildew and the formation of frost or ice on any panel surface and must not allow inner-wall condensation. Provide calculations complying with the ASHRAE Handbook of Fundamentals – Theory of Water Vapor Migration and confirming the requirements for effective moisture condensation prevention. See HVAC DESIGN DATA in Section 01 11 10 - Summary Of Work-General.

E. 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.

F. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 120 deg F. Use other values, greater or smaller, whenever justified by climatic conditions at the project site.

G. Calculated Fire-Test-Response Characteristics: Where indicated, provide units whose fire resistance has been calculated according to PCI MNL 124, and is acceptable to authorities having jurisdiction.

H. Comply with requirements of Section 01 43 39 – Mockups. If requirements conflict with requirements stated in this Section, comply with the more stringent condition.

1.7 BLAST REQUIREMENTS

A. Blast Requirements:

1. As specified in Section 03 45 00.30 - Blast Resistant Requirements for Precast Architectural Concrete, Life Safety Buildings.
2. As specified in Section 03 45 00.50 - Blast Resistant Requirements for Precast Architectural Concrete, Mission Critical Rated Buildings.

1.8 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Engineer's Seal/Signature: Shop drawings and associated calculations required for structural design shall bear seal and signature of Professional Engineer. See Professional Engineer under QUALITY ASSURANCE above, and "Comprehensive Engineering Analysis" below.

C. 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.

1. Provide documentation of alkali resistance of connector and long-term shear capacity of connector.

D. Design Mixes: For each concrete mix along with compressive strength and water-absorption tests.

E. 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. Indicate locations, extent and treatment of dry joints if two-stage casting is proposed.
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. Indicate locations and details of facing materials, anchors, and joint widths.
8. Design Modifications:

    a. 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.
9. Anchorage Drawings for Structural Support Provided by this Section:
    a. Show embed types and layouts, anchorage locations, types and sizes of anchors, and proposed methods of attachment to structure.
    b. Show details of anchors. Include range of adjustment for each anchor type and bolt size, including those perpendicular to face of building.
    c. Describe all materials including shimming devices.
    d. Indicate all reactions or loads-imposed-on structure imposed on structure under maximum design load conditions for Engineer to review.
    e. Shimming Depths: For each type of anchorage to structure, show maximum allowable depths of shims permitted for normal conditions. Show details for shim depths exceeding normal conditions.

F. Provide detailed instructions and drawings for removal and reinstallation of precast concrete access panels of sizes and locations indicated on drawings. Comprehensive Engineering Analysis: Provide calculations signed and sealed by the qualified Professional Engineer 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.

G. Provide narrative on fabrication methods and techniques that will be used to assure that PERFORMANCE REQUIREMENTS for the vapor retarder at insulated concrete sandwich panels are obtained.

H. Samples: Samples for each facing unit required, showing the full range of color and texture expected. Supply sketch of each corner or special shape with dimensions. Supply sample showing color and texture of joint treatment.

    1. Submit for approval samples representative of finished exposed face showing typical range of finishes, color, and texture of exposed surfaces of units; before production of job mock-up specified in Quality Assurance.
    2. Sample Size: Minimum 24 inch x 24 inch of appropriate thickness, representative of the proposed finished product.
    3. Sample to match Architects precast concrete sample.

I. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel.

J. Qualification Data for fabricator and Professional Engineer: List of completed projects with project names and addresses, names and addresses of Resident Engineers and owners, and other information specified.

K. SUBMITTALS required for this Sections shall be submitted complete and concurrently with Blast Submittals. Partial submittals are not acceptable.
    1. Blast Submittals: SUBMITTALS as specified in:
        a. Section 03 45 00.30 - Blast Resistant Requirements for Precast Architectural Concrete, Life Safety Buildings.

b. Section 03 45 00.50 – Blast Resistant Requirements for Precast Architectural Concrete, Mission Critical Rated Buildings.

2. Include work provided by this Section and specified elsewhere.

L. Design Certification: Submit notarized certification that the units and their connections have been designed to comply with this Section by a Professional Engineer registered in the state in which the Project is located and experienced in the design of architectural precast concrete.

M. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with specifications, concrete mix designs, compressive strength tests on concrete, and water absorption tests on units.

1. Color Additive: If used, submit documentation proposed material complies with ASTM C 979.

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

1. Concrete materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Structural-steel shapes and hollow structural sections.
6. Insulation
7. Facing units.
8. Anchors.

1.9 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.

1.10 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.

1.11 APPLICABLE PUBLICATIONS (Latest edition unless otherwise noted)

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):

1. A27/A27M Steel Castings, Carbon, for General Application
2. A36/A36M Carbon Structural Steel
3. A47/A47M Ferritic Malleable Iron Castings
4. A82 Steel Wire, Plain, for Concrete Reinforcement
5. A108 Steel Bar, Carbon and Alloy, Cold-Finished
6. A123/A123M Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
7. A153/A153M Zinc Coating (Hot-Dip) on Iron and Steel Hardware
8. A167 Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
9. A184/A184M Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
10. A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
11. A276 Stainless Steel Bars and Shapes
12. A283/A283M Low and Intermediate Tensile Strength Carbon Steel Plates
13. A307 Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
14. A325/A325M Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
15. A416/A416M Steel strand, Uncoated Seven-Wire for Prestressed Concrete
16. A490/A490M Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
17. A496 Steel Wire, Deformed, for Concrete Reinforcement
18. A497 Steel Welded Wire Reinforcement, Deformed, for Concrete
19. A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
20. A563/A563M Carbon and Alloy Steel Nuts
21. A572/A572M High-Strength Low-Alloy Columbium-Vanadium Structural Steel
22. A615/A615M Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
23. A666 Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
24. A675/A675M Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
25. A706/A706M Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
26. A767/A767M Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
27. A780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
28. A884/A884M Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
29. A934/A934M Epoxy-Coated Prefabricated Steel Reinforcing Bars
30. B227 Hard-Drawn Copper-Clad Steel Wire
31. B633 Electrodeposited Coatings of Zinc on Iron and Steel
32. C33 Concrete Aggregates
33. C40 Organic Impurities in Fine Aggregate for Concrete
34. C150 Portland Cement
35. C260 Air-Entraining Admixtures for Concrete
36. C330 Lightweight Aggregates for Structural Concrete
37. C373) Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products

38. C494/C494M Chemical Admixtures for Concrete
39. C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
40. C881/C881M Epoxy-Resin-Base Bonding Systems for Concrete
41. C979 Pigments for Integrally Colored Concrete
42. C989 Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
43. C1017/C1017M Chemical Admixtures for Use in Producing Flowing Concrete
44. C1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
45. C1218/C1218M Test Method for Water-Soluble Chloride in Mortar and Concrete
46. C1240 Silica Fume Used in Cementitious Mixtures
47. D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
48. D2240-03 Test Method for Rubber Property—Durometer Hardness
49. F436/F436M Hardened Steel Washers
50. F568M Carbon and Alloy Steel Externally Threaded Metric Fasteners
51. F593 Stainless Steel Bolts, Hex Cap Screws, and Studs
52. F844 Washers, Steel, Plain (Flat), Unhardened for General Use

C. American Concrete Institute (ACI):

1. ACI 211.1 Selecting Proportions for Normal, Heavyweight and Mass Concrete (Reapproved 2002)
2. ACI 318/318M Building Code Requirements for Structural Concrete

D. American Association of State Highway and Transportation Officials

1. AASHTO LFRD LRFD Bridge Design Specifications, U.S., 3rd Edition
2. AASHTO M251 Elastomeric Bearings

E. Precast/Prestressed Concrete Institute (PCI):

1. MNL-117 Quality Control for Plants and Production of Architectural Precast Concrete Products
2. MNL-120 Design Handbook – Precast and Prestressed Concrete
3. MNL-124 Design for Fire Resistance of Precast Prestressed Concrete.
4. MNL-127 Erector’s Manual - Standards and Guidelines for the Erection of Precast Concrete Products
5. MNL-135 Tolerance Manual for Precast and Prestressed Concrete Construction
6. TR-6 Interim Guidelines for the Use of Self-Consolidating Concrete

F. Military Specifications (MIL. Spec):

1. MIL-C882E Cloth, Duck, Cotton or Cotton-Polyester Blend Synthetic Rubber, Impregnated, and Laminated, Oil Resistant.

G. Structural Steel Painting Council (SSPC):

1. SSPC-Paint 20 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.

C. Steel Bar Mats: ASTM A184/A184M, assembled with clips.

D. Plain-Steel Welded Wire Reinforcement: ASTM A185, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded Wire Reinforcement: ASTM A497, flat sheet.

F. Prestressing Strand: ASTM A416/A416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.

G. 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. 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: To match design approved mockup.
b. Hard durable quartz, marble, granite, siliceous stone, limestone, or other aggregate, carefully graded from coarse to fine in proportions required to match approved samples.

c. 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 Architect..

a. Test sand for color value in accordance with ASTM C40. Sand producing darker than specified color standard is unacceptable.
b. Clean washed white silica sand.

C. Unexposed Surface (Backup) Concrete Aggregates: ASTM C33.

D. 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.

E. 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.

F. Match Architect's approved samples, which can be viewed at pre-bid meeting.

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 < 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.

2.5 Carbon-Steel Castings: ASTM A27/A27M, Grade U-60-30 (Grade 415-205).

A. 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 < 0.09 is also acceptable.

B. Carbon-Steel Structural Tubing: ASTM A500, Grade B.

C. Wrought Carbon-Steel Bars: ASTM A675/A675M, Grade 65 (Grade 450).

D. Deformed-Steel Wire or Bar Anchors: ASTM A496 or ASTM A706/A706M.

E. 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,A); and flat, unhardened steel washers (ASTM F844).

F. 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).

G. Finish: For steel in exterior walls and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A123/A123M, after fabrication.

H. 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.

I. Welding Electrodes: Comply with AWS standards.

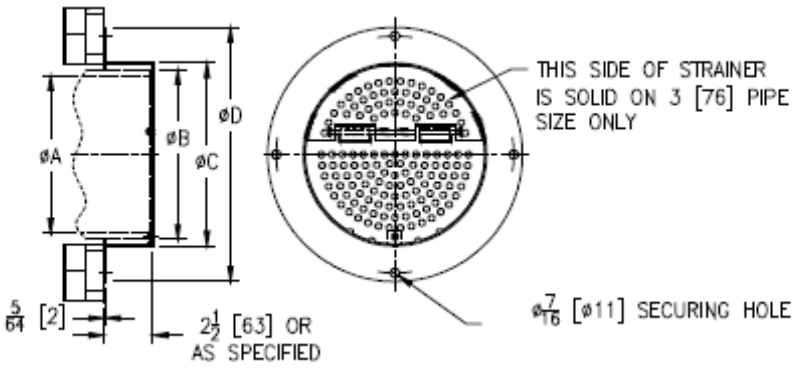
J. Wythe Connectors: Comply with INSULATED PANEL ACCED/SSORIES, specified below.

2.6 ACCESSORIES

A. Reglets: Provide where shown.
   1. Cast in Place Reglets: Stainless steel, ASTM A167, Type 302 felt or fiber filled or cover face opening of slots.
   2. Contractor Option: Cut joints in field. Locations of cut joints shall be shown on shop drawings.

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

C. Downspout Cover:
   1. Coordination:
      a. Provide factory cut round opening in exterior wall system for installation of piping by Division 22. Opening to approximately 1/2" larger than outside diameter of downspout cover inlet (Dimension "C" below).
      b. Provide concealed blocking for support of scupper and securing supper fasteners through wall system to blocking. Pipe provided Division 22 shall be supported by Division 22.
   2. Downspout Cover will be provided by Division 22. The information below regarding the downspout cover is for information only.
   3. Basis of Design: Model Number "Z199-DC" Downspout Cover.
      a. Manufacturer: Zurn Plumbing Products.
   4. Exposed Material: Stainless steel.
   5. Fasteners: Stainless steel fastener with Robertson type head finish.
   6. Size: Match to pipe size provided by Division 22 for piping to the scupper.
      a. Default: If not indicated in EWP-6, Construction Manager shall base bid on nominal 6" inside diameter pipe and verify required size with Resident Engineer prior to submitting "SUBMITTALS" for this specification Section.
   7. Appearance and Profile: As shown below.



D. Miscellaneous: All materials, tools, equipment, hardware, and devices required for complete installation.

2.7 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.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107, Grade A for drypack and Grades B and C for flowable grout and of a consistency suitable for application within a 30-minute working time.

C. Epoxy-resin grout: Two-component mineral-filled epoxy-resin: ASTM C881 of type, grade, and class to suit requirements.

2.8 SEALANT

A. Sealant: Two-Stage sealant joints provided by Section 07 92 00 - Joint Sealants, between precast architectural concrete panels.

B. Preformed Silicone Joint Sealants and Silicone Sealant: Provide in conformance with Section 07 92 00 - Joint Sealants.

2.9 INSULATED PANEL ACCED/SSORIES

A. Rigid Insulation: Extruded-Polystyrene Board Insulation, ASTM C 578, Type IV, 1.60 lb/cu. ft. ; with typical R-value of 10 and thickness of 2 inches. Insulation may be reduced to 1 inch thickness in locations to meet structural design requirements; but the system must perform to obtain the equivalent of a continuous R value of 5.0.

1. One layer, two inches thick,
   a. R–Value: 10.

2. Insulation shall have holes identifying connector placement locations for glass-fiber and vinyl-ester polymer connectors.
3. Compressive resistance: 25-psi minimum at yield or at 10 percent deformation per ASTM D1621.
4. Flexural strength: 50.0-psi minimum
5. Water Absorption: 0.1 percent maximum by volume per ASTM C272.
6. ISR R-Value: 5.0°F•ft^2•h/Btu per inch at 75° F minimum per ASTM C518. Warranted R-Value to retain minimum of 90 percent of its published R-value for 15 years.
7. Manufactured with a blowing agent that provides at least a 90 percent reduction in potential for ozone depletion as compared to standard CFC blowing agents.

B. Sealant Tape for Rigid Insulation: Butyl sealant tape.
   1. Manufacturer: Manufactured by manufacturer of the rigid insulation or as recommended by the manufacturer of the rigid insulation.
   2. Properties:
      a. Self-adhering tape: Butyl adhesive backed with a foil based composite facer or high-density poly- ethylene (HDPE) film facer; with paper release liner.
      b. Self-sealing, self-healing, fully adhered flashing engineered for exceptional long term adhesion to extruded-polystyrene board insulation.
      c. Width: 4 inches, minimum.
      d. Thickness: 11 mils, minimum.
      e. Water Vapor Transmission: Less than 1 perm, ASTM E96.
      f. Application Temperature: 30 degrees Fahrenheit.
      g. UV Resistance, days: 120.

C. Insulation Adhesive: Product recommended by manufacturer of rigid insulation for adhering rigid insulation together at edges. Insulation Adhesive must be compatible with wythe connectors.

D. Wythe Connectors: Use one or both of the following wythe connectors to meet PERFORMANCE REQUIREMENTS.

   1. Glass-fiber and vinyl-ester polymer connectors, manufactured to connect wythes of concrete panels.
      a. Non-conductive,
      b. Non-corrosive,
      c. Tensile strength of 120,000 psi, minimum.
      d. Central body of connector shall be provided with flange to limit insertion depth into insulation and a profile to prevent connector from backing out of insulation after installation.

   2. A non-metallic, non-woven carbon fiber connectors, manufactured to connect wythes of concrete panels and develop composite action between inner and outer wythes of a concrete panel.
      a. Basis of Design: C-GRID® Shear Truss manufactured by CHOMARAT North America.
         1) Grid Truss Properties: C50 – 1.8 x 1.6
            a) Sheet Width, Nominal: 47 inches
            b) Sheet Length , Nominal: 67 inches
         2) Construction (strands/ft):
            a) Machine Direction: 6.7 ends/ft, ASTM D-3375.
            b) Cross Machine: 7.5 ends/ft, ASTM D-3375.
         3) Minimum Tensile (lb):
            a) Machine Direction: 830 average.
            b) Cross Machine: 7.5 ends/ft.

4) Thickness: 0.12", per ASTM D-5129-9

b. Yarn/Strand Direction: Warp and Weft Strands to be laid perpendicular to each other; warp yarns to be superimposed.
c. Cross over bond: Fully bonded to ensure proper tow integrity.
d. Strands: No missing, broken, or degraded strands.
e. Binder Type: Epoxy.
f. Yarn Type: Carbon fiber tow.

3. A thin, non-metallic, two-dimensional composite truss connector made from continuous wound alkali resistant Zirconium Glass fibers in an alkali resistant Bisphenol A type Epoxy Vinyl Ester resin designed for construction of insulated concrete panels. A high strength, low conductivity and chemically resistant connectors designed and manufactured to connect wythes of concrete panels and develop composite action between inner and outer wythes of a concrete panel.
   a. Non-corrosive
   b. Thermal Conductivity: 0.25 W/mC.
   c. Coefficient of Thermal Expansion: Same as concrete.
   d. Tensile and Shear Capacity per Tie: 3,000 lbs.

2.10 CONCRETE MIXES

A. Prepare design mixes to match approved mockup for each type of concrete required.

   1. Limit use of fly ash and silica fume to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent 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. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.

F. 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.

G. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

2.11 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: Uniformly 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.

2.12 FABRICATION

A. Manufacturing Procedures: In accordance with PCI MNL 117.

1. Panels: Sizes and profiles as shown.
2. Coping: Size and profile as shown.
3. Prestressing is permissible, provided it does not induce deformations in excess of the referenced tolerances.

B. 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.

1. Weld headed studs and deformed bar anchors used for anchorage.

C. 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.

D. Cast-in reglets, slots, holes, and other accessories in units as indicated.

E. 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.

F. Reinforcement: Comply with recommendations in PCI MNL 117 for fabrication, placing, and supporting reinforcement.

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

2. Place reinforcing steel and prestressing strand to maintain at least 3/4 inch minimum concrete cover. Increase cover requirements for reinforcing steel to1-1/2 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. Direct wire tie ends away from finished, exposed concrete surfaces.

3. 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.

G. Prestress tendons for units by pretensioning methods. Comply with PCI MNL 117.

1. Protect strand ends and anchorages with bituminous, zinc-rich or epoxy paint to prevent corrosion and rust spots.

H. 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.

I. 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.

J. 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. Pickup points not permitted at panel edges or faces exposed to view or weather.

K. Cure concrete, according to requirements in PCI MNL 117 at an interior location. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

L. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

2.13 PANEL IDENTIFICATION:

A. Provide permanent markings in units to identify location within the structure, date cast, and lifting points. Locate markings to be unexposed in the finished building.

B. Mark each precast panel to correspond to identification mark on shop drawings for panel location.

2.14 INSULATED PANEL CASTING

A. Rigid Insulation: Prefabricate rigid insulation complete with wythe connectors installed or penetrations for wythe connectors created. Provide continuous insulation, with wythe connectors between the two concrete layers. Unless specifically detailed, there should be no full-wall

thickness concrete sections; insulation extends continuous edge to edge of panel width and height. Butt joints of rigid insulation tight together and install in manor that meets or exceeds PERFORMANCE REQUIREMENTS for vapor retarder.

1. Tape joints in insulation on both sides of insulation board after butting joints tight, or adhere edges of board together. Center tape over joint and press tape firmly to board to insure uniform adhesion, while removing release paper. Lap material a minimum of three inches.
2. Contractor's Option: At roof parapet conditions the insulation between concrete may be deleted if needed for additional strength of precast panel. The extent of insulation that maybe deleted starts at 8 inches below top of concrete roof deck and extends top of parapet. Insulation shall be replaced with concrete.

B. Cast and screed supported wythe over mold.

C. Install prefabricated insulation panels and insert wythe connectors through insulation consolidate concrete around connectors according to connector manufacturer's written instructions. Seal to maintain vapor retarder qualities of rigid insulation.

D. Ensure that concrete does not reach initial set before installation of the insulation and connectors. Do not disturb the lower wythe concrete or the insulation layer after the lower wythe concrete has reached initial set or before the lower wythe concrete has hardened.

1. Consolidate plastic concrete around the embedded ends of the connectors using one or more of the following methods to ensure complete consolidation around the connector ends:
   a. Careful walking foot pressure applied to top of insulation around each connector to develop fluid concrete pumping pressure.
   b. Vibrating forms.
   c. Mechanical vibration applied to each connector.
2. Bottom-Cast Concrete: Monitor the concrete temperature with thermal probes and adjust tem for each panel configuration to meet requirements of PCI MNL 117.
3. Ensure that the concrete in the first layer is fully consolidated around each connector prior to placing the upper layer of concrete.
4. Cast panels at an indoor facility.

E. Cast and screed top wythe to meet required finish.

2.15 FABRICATION TOLERANCES

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

1. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:
   a. 10 feet (3 m) or under, plus or minus 1/8 inch (3 mm).
   b. 10 to 20 feet (3 to 6 m), plus 1/8 inch (3 mm), minus 3/16 inch (5 mm).
   c. 20 to 40 feet (6 to 12 m), plus or minus 1/4 inch (6 mm).
   d. Each additional 10 feet (3 m), plus or minus 1/16 inch (1.5 mm).
2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
   a. 10 feet (3 m) or under, plus or minus 1/4 inch (6 mm).
   b. 10 to 20 feet (3 to 6 m), plus 1/4 inch (6 mm), minus 3/8 inch (10 mm).
   c. 20 to 40 feet (6 to 12 m), plus or minus 3/8 inch (10 mm).

d. Each additional 10 feet (3 m), plus or minus 1/8 inch (3 mm).

3. Total Thickness or Flange Thickness: Plus 1/4 inch (6 mm), minus 1/8 inch (3 mm).
4. Rib Thickness: Plus or minus 1/8 inch (3 mm).
5. Rib to Edge of Flange: Plus or minus 1/8 inch (3 mm).
6. Distance between Ribs: Plus or minus 1/8 inch (3 mm).
7. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1830 mm) or 1/2 inch (13 mm) total, whichever is greater.
8. Length and Width of Block-outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
9. Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 3/4 inch (19 mm).
10. Dimensions of Haunches: Plus or minus 1/4 inch (6 mm).
11. Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 1/8 inch (3 mm).
12. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 1/4 inch (6 mm).
13. Bowing: Plus or minus L/360, maximum 1 inch (25 mm).
14. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
15. Warping: 1/16 inch per 12 inches (1.5 mm per 300 mm) of distance from nearest adjacent corner.
16. Tipping and Flushness of Plates: Plus or minus 1/4 inch (6 mm).
17. Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch (3 mm).
18. Camber or sweep: Plus or minus 1/8 inch per 10 feet of length, up to 1/2 inch maximum. Differential between 2 adjacent units shall be no more than 1/2 the maximum allowed.
19. Squareness of units and openings: Plus or minus 1/8 inch per 6 feet of length, measured along diagonal.
20. Joint Width: See "Joint Width" under SYSTEM DESCRIPTION above. This tolerance shall take precedence over "Length and Width" tolerances above.

B. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.

1. Weld Plates: Plus or minus 1 inch (25 mm).
2. Inserts, bolts, pipe sleeves, and other cast-in-place items: Plus or minus 3/8 inch from drawing location.
3. Handling Devices: Plus or minus 3 inches (75 mm).
4. Reinforcing Steel and Welded Wire Fabric: Plus or minus 1/4 inch (6 mm) where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch (13 mm).
5. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch (13 mm) of plan dimensions.
6. Tendons: Plus or minus 1/4 inch (6 mm), vertical; plus or minus 1 inch (25 mm), horizontal.
7. Location of Rustication Joints: Plus or minus 1/8 inch (3 mm).
8. Location of Opening within Panel: Plus or minus 1/4 inch (6 mm).
9. Location of Flashing Reglets: Plus or minus 1/4 inch (6 mm).
10. Location of Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch (3 mm).
11. Reglets for Glazing Gaskets: Plus or minus 1/8 inch (3 mm).
12. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch (13 mm).
13. Location of Bearing Surface from End of Member: Plus or minus 1/4 inch (6 mm).
14. Allowable Rotation of Plate, Channel Inserts, and Electrical Boxes: 2-degree rotation or 1/4 inch (6 mm) maximum over the full dimension of unit.
15. Position of Sleeve: Plus or minus 1/2 inch (13 mm).

C. Fabricate architectural trim units such as sills, lintels, coping, cornices, quoins, medallions, bollards, benches, planters, and pavers, with tolerances meeting PCI MNL 135.

2.16 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 mockups and as follows:

B. Panel Face Types: Appearance including color, mix, profile, and texture.

1. Exposed Horizontal and Vertical Exterior Surfaces: Match finish of approved mockup panels. Types as shown on the Drawings:

a. Type PC-1:
1) Texture: Smooth.
2) Finish: Light Acid Etch.
3) Profile: As indicated on drawings.

2. Exposed Vertical Interior Surfaces: Smooth float finish after striking surfaces flush to form finish lines.
3. Top, Bottom, and Edges: As cast finish using smooth, non-porous molds.
4. Concealed Surfaces: Same as Exposed Vertical Interior Surfaces except surfaces receiving joint sealant, specified elsewhere, to be smooth as cast.
5. Wing Walls: Exposed finish on the back side of panel and finish on the edges shall very closely match Architect's sample and the finished face of adjacent concrete panels.

2.17 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. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

C. Testing: If there is evidence that the concrete strength of precast concrete units may be deficient, precast architectural concrete fabricator 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 architectural 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.

b. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

2. 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 Architect and Resident Engineer reserve 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.

D. Keep quality control records available for the Architect and Resident Engineer upon request for a minimum of 4 years after final acceptance. These records shall include mix designs, test reports, inspection reports, member identification numbers along with date cast, shipping records and erection reports.

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 cast-in place concrete has attained minimum allowable design strength or supporting steel 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.
   a. Cover recess, such as those left be bridge edge lifter locations, at panel surface receiving sealant patch opening with Preformed Silicone Joint Sealants and Silicone Sealant and install in conformance with Section 07 92 00 - Joint Sealants. Lap a minimum of 1 inch over concrete and create a continuous flat surface for installation of sealant and backer rod.

4. Joint Width: Unless otherwise shown provide for uniform joint widths of 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 roof flashing continuity by connections is not permitted; concealment within roof insulation is acceptable.

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. Sealing of Joints: Two-Stage sealant joints provide by Section 07 92 00 - Joint Sealants between precast architectural concrete panels.

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, and as specified in Part 2 above.

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 and foreign 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, stains, and foreign material.

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 034500.30
BLAST RESISTANT REQUIREMENTS FOR PRECAST ARCHITECTURAL CONCRETE, LIFE SAFETY BUILDINGS

PART 1 - GENERAL

1.1 REFERENCES

A. Physical Security Design Manual (PSDM) July 2007, for Veteran Affair Life Safety Protected, Final Draft.

1.2 RELATED SECTIONS

A. Blast Loads: Section 01 83 16.23 Exterior Blast Dynamic Loading

B. Precast Architectural Concrete: Section 03 45 00 Precast Architectural Concrete

1.3 SYSTEM DESCRIPTION

A. General Description: Precast panels act as the building envelope for much of the face of the buildings. The requirements of this section apply to the design of panels subject to blast loading. Design for all other loading is outside of the scope of this section.

B. Design Requirements:
1. Minimum performance requirements for blast resistant precast concrete panels are specified herein for a VA building designed as a Life Safety Protected building in accordance with the PSDM. All exterior precast panels are blast resistant unless noted otherwise.
2. In conjunction with meeting aesthetic and performance requirements, the Contractor may propose alternate detailing methods for consideration.
3. Minimum performance requirements for blast resistant precast concrete panels are specified.
4. Use dynamic analysis to design the precast concrete panels.
5. Reinforcing: Precast sub-contractor to perform final analysis and design, in accordance with design and performance criteria included in this specification.
6. Precast Insulated Wall Panels:
   a. Precast insulated wall panels may be used. To analyze the inner and outer wythes of the panel as a composite section, shear transfer across the insulation layer shall be provided.
      1) Through testing or calculations, demonstrate that the shear transfer system has sufficient capacity to allow the inner and outer wythes to behave with 100% composite action.
      2) Alternatively, the panels may be designed with no shear transfer between wythes, in which case the panel shall be designed based upon the section properties of the single wythe that connects directly to the structure.
7. Panel Connections:
   a. Connections resisting blast forces shall be capable of resisting horizontal inward and outward out-of-plane forces at a minimum. Rebound loads must be calculated or conservatively can be assumed as 100% of the inward blast load. Design of

connections to resist other loads, including gravity, and to accommodate building drift is the responsibility of the Contractor.

b. Provide a minimum of 2 blast resisting connections at the top of all panels and 2 blast resisting connections at the bottom of all panels. Contractor may propose alternate connection layouts for panels which provide stability against out-of-plane loads and meet all other project requirements.

c. Panel connections to be designed to develop the maximum capacity of the precast panel, or to resist the maximum load that can be delivered by the supported precast panel system.

d. Panel lateral connections to columns not level with and tied directly to the floor slab are prohibited unless an advanced analysis of the load bearing element demonstrates it can accept the maximum forces of the members framing into it without compromising its capacity. Owner approval for all connections to columns not level with the floor slab is also required.

e. Spandrel Panels
   1) All spandrel panels will have at least 4 lateral connections with at least 2 connections to floor systems.
   2) Spandrel panels adjacent to vertical panels without column backup must have 4 lateral connections to floor systems.

f. Panel to panel connections, if used, are to:
   1) Transmit required shear
   2) Minimize rotation

g. The design of floor framing for adequacy in resisting all forces including panel blast connection reactions shall be coordinated with and is the responsibility of the structural engineer of record.

C. Performance Requirements:
   1. General: Provide design of exterior precast panels to meet the minimum requirements of the PSDM.
   2. Acceptable Panel Response: Panels are limited to a deflection of L/30.
   3. Acceptable Panel Yield Mode: Panels with a ductility of greater than 1.0 shall be detailed to exhibit flexural tension yielding behavior. Other yield modes are not acceptable.
   4. Design Blast Loads:
      a. Unless otherwise indicated on the Pressure Zone drawings, the design loading for dynamic analysis is: Ramp down load with a peak pressure of 4 psi and impulse of 28 psi-msec. This design load shall be applied over the areas tributary to the element being analyzed. At locations indicated in the Pressure Zone drawings, design for a peak pressure and impulse as noted in Section 01 83 16.23 Exterior Blast Dynamic Loads.
      b. Applying Design Load: Apply air blast pressure and impulse over the appropriate tributary area that is carried by the precast panel. Tributary area includes the surface area of the panel and the associated window areas.

SEE RFI 04024 FOR PRESSURE ZONE DRAWINGS.

1.4 SUBMITTALS

A. Calculations: Provide calculations prepared by qualified blast consultant verifying that panels meet specific blast resistance requirements detailed in this Section.
   1. Prior to performing engineering calculations intended to address the blast loading identified, submit to the Owner's Blast Consultant for review a description of the technique(s) that will be employed to calculate the response of the system to the defined dynamic loading.

2. Submit calculations to Owner's Blast Consultant for review prior to start of panel fabrication. Calculations shall include a summary of blast reaction forces to be resisted at all panel connection points by the supporting structure. The structural engineer of record shall review these reaction forces to confirm the adequacy of the supporting structure.
   a. Calculation package is to include a summary sheet briefly outlining the following:
      1) Evaluation criteria
      2) Calculation assumptions
      3) Table of results by window type/location
      4) Statement of Conformance with specification requirements.
      5) Blast calculations are to be appropriately keyed to the precast shop drawing panel and connection numbering scheme
      6) Blast calculations are to be submitted at the same time as the related shop drawings
3. Submit analysis for panels and connections. Submit engineering calculations to show that maximum rotation for all panels does not exceed specified performance requirements under specified design load. These calculations must include, but may not be limited to, analysis of the following:
   a. Precast Concrete Panels. Analyze all sections, including reinforcement.
   b. Panel Connections: Analyze all connections between panels, and between panels and the supporting structure.
   c. Failure Modes: Provide analysis to illustrate that brittle modes of failure (such as shear, buckling and concrete pull-out) are avoided in all components of the system including connections.
4. Calculation submittal is to be stamped and signed by a registered Professional Engineer whose qualifications meet or exceed Quality Assurance criteria.

B. Certificates: Engineer's qualifications that meet or exceed Quality Assurance criteria: At a minimum, qualifications must list each project in which the Engineer performed analysis of precast systems, the effective start and end dates of performance of the analysis and a reference.

1.5 QUALITY ASSURANCE

A. Provide products that meet the requirements of Physical Security Design Manual (PSDM) July 2007, for Veteran Affair Life Safety Protected, Final Draft.

B. Engineer: Engage a licensed Engineering Professional acceptable to the owner to perform dynamic analysis of the Blast Resistant Panels. The Blast Engineer shall have a minimum of 5 years experience in blast resistant design and demonstrable experience designing blast resistant concrete systems to comparable load requirements in the past 18 months.

C. Fabricators of precast concrete panels and windows must coordinate work to ensure the adequacy of the precast panels to support the blast loads tributary to the glass and the anchorage forces from the window systems. Should the glazing design change then the panels must be checked for the capacity of the revised glass type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver prefabricated units to Project as completely assembled units, ready for anchorage into supporting structure, and for interfacing with other work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Precast Concrete: Use normal weight concrete with a compressive strength of 5000 psi or greater.
   1. Reinforcement: If dynamic analysis is used, the compressive strength of concrete and yield strength of reinforcement may be increased to account for dynamic strain rate effects as follows:
      a. Reinforcing Steel: For fy = 60 ksi, the yield strength may be increased by a factor of 1.30.
      b. Concrete: Compressive strength may be increased by a factor of 1.17.

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SECTION 034500.50
BLAST RESISTANT REQUIREMENTS FOR PRECAST ARCHITECTURAL CONCRETE, MISSION CRITICAL RATED BUILDINGS

PART 1 - GENERAL

1.1 REFERENCES

A. Physical Security Design Manual (PSDM) July 2007, for Veteran Affair Mission Critical Facilities, Final Draft.

1.2 RELATED SECTIONS

A. Blast Loads: Section 01 83 16.23 Exterior Blast Dynamic Loading

B. Precast Architectural Concrete: Section 03 45 00 Precast Architectural Concrete

1.3 SYSTEM DESCRIPTION

A. General Description: Precast panels act as the building envelope for much of the face of the buildings. The requirements of this section apply to the design of panels subject to blast loading. Design for all other loading is outside of the scope of this section.

B. Design Requirements:
1. Minimum performance requirements for blast resistant precast concrete panels are specified herein for a VA building designed as a Mission Critical building in accordance with the PSDM. All exterior precast panels are blast resistant unless noted otherwise.
    a. The following buildings have been assigned a VA PSDM status of 'Mission Critical':
        1) Inpatient Wings (Building 1)
        2) Diagnostics and Testing Building (Building 2)
        3) Transitional Living Building (Building 6): Only the separated gymnasium structure is a Mission Critical rated structure.
        4) Central Energy Plant (Building 7): The Central Energy Plant and Service Building are structurally separated but combined are classified as Building 7. The Central Energy Plant portion only is a Mission Critical rated structure.
        5) Research Building (Building 8): The research building consists of an existing building and façade with a new added structure. The new structure only is classified as a Mission Critical rated structure.
2. In conjunction with meeting aesthetic and performance requirements, the Contractor may propose alternate detailing methods for consideration.
3. Minimum performance requirements for blast resistant precast concrete panels are specified.
4. Use dynamic analysis to design the precast concrete panels.
5. Reinforcing: Precast sub-contractor to perform final analysis and design, in accordance with design and performance criteria included in this specification.
6. Precast Insulated Wall Panels:
    a. Precast insulated wall panels may be used. To analyze the inner and outer wythes of the panel as a composite section, shear transfer across the insulation layer shall be provided.

1) Through testing or calculations, demonstrate that the shear transfer system has sufficient capacity to allow the inner and outer wythes to behave with 100% composite action.
2) Alternatively, the panels may be designed with no shear transfer between wythes, in which case the panel shall be designed based upon the section properties of the single wythe that connects directly to the structure.

7. Panel Connections:
   a. Connections resisting blast forces shall be capable of resisting horizontal inward and outward out-of-plane forces at a minimum. Rebound loads must be calculated or conservatively can be assumed as 100% of the inward blast load. Design of connections to resist other loads, including gravity, and to accommodate building drift is the responsibility of the Contractor.
   b. Provide a minimum of 2 blast resisting connections at the top of all panels and 2 blast resisting connections at the bottom of all panels. Contractor may propose alternate connection layouts for panels which provide stability against out-of-plane loads and meet all other project requirements.
   c. Panel connections to be designed to develop the maximum capacity of the precast panel, or to resist the maximum load that can be delivered by the supported precast panel system.
   d. Panel lateral connections to columns not level with and tied directly to the floor slab are prohibited unless an advanced analysis of the load bearing element demonstrates it can accept the maximum forces of the members framing into it without compromising its capacity. Owner approval for all connections to columns not level with the floor slab is also required.
   e. Spandrel Panels
      1) All spandrel panels will have at least 4 lateral connections with at least 2 connections to floor systems.
      2) Spandrel panels adjacent to vertical panels without column backup must have 4 lateral connections to floor systems.
   f. Panel to panel connections, if used, are to:
      1) Transmit required shear
      2) Minimize rotation
   g. The design of floor framing for adequacy in resisting all forces including panel blast connection reactions shall be coordinated with and is the responsibility of the structural engineer of record.

C. Performance Requirements:
   1. General: Provide design of exterior precast panels to meet the minimum requirements of the PSDM.
   2. Acceptable Panel Response: Panels are limited to a deflection of L/30.
   3. Acceptable Panel Yield Mode: Panels with a ductility of greater than 1.0 shall be detailed to exhibit flexural tension yielding behavior. Other yield modes are not acceptable.
   4. Design Blast Loads:
      a. Unless otherwise indicated on the Pressure Zone drawings, the design loading for dynamic analysis is: Ramp down load with a peak pressure of 4 psi and impulse of 28 psi-msec. This design load shall be applied over the areas tributary to the element being analyzed. At locations indicated in the Pressure Zone drawings, design for a peak pressure and impulse as noted in Section 01 83 16.23 Exterior Blast Dynamic Loads.
      b. Applying Design Load: Apply air blast pressure and impulse over the appropriate tributary area that is carried by the precast panel. Tributary area includes the surface area of the panel and the associated window areas.

1.4 SUBMITTALS

A. Calculations: Provide calculations prepared by qualified blast consultant verifying that panels meet specific blast resistance requirements detailed in this Section.
   1. Prior to performing engineering calculations intended to address the blast loading identified, submit to the Owner's Blast Consultant for review a description of the technique(s) that will be employed to calculate the response of the system to the defined dynamic loading.
   2. Submit calculations to Owner's Blast Consultant for review prior to start of panel fabrication. Calculations shall include a summary of blast reaction forces to be resisted at all panel connection points by the supporting structure. The structural engineer of record shall review these reaction forces to confirm the adequacy of the supporting structure.
      a. Calculation package is to include a summary sheet briefly outlining the following:
         1) Evaluation criteria
         2) Calculation assumptions
         3) Table of results by window type/location
         4) Statement of Conformance with specification requirements.
         5) Blast calculations are to be appropriately keyed to the precast shop drawing panel and connection numbering scheme
         6) Blast calculations are to be submitted at the same time as the related shop drawings
   3. Submit analysis for panels and connections. Submit engineering calculations to show that maximum rotation for all panels does not exceed specified performance requirements under specified design load. These calculations must include, but may not be limited to, analysis of the following:
      a. Precast Concrete Panels. Analyze all sections, including reinforcement.
      b. Panel Connections: Analyze all connections between panels, and between panels and the supporting structure.
      c. Failure Modes: Provide analysis to illustrate that brittle modes of failure (such as shear, buckling and concrete pull-out) are avoided in all components of the system including connections.
   4. Calculation submittal is to be stamped and signed by a registered Professional Engineer whose qualifications meet or exceed Quality Assurance criteria.

B. Certificates: Engineer's qualifications that meet or exceed Quality Assurance criteria: At a minimum, qualifications must list each project in which the Engineer performed analysis of precast systems, the effective start and end dates of performance of the analysis and a reference.

1.5 QUALITY ASSURANCE

A. Provide products that meet the requirements of Physical Security Design Manual (PSDM) July 2007, for Veteran Affair Mission Critical Facilities, Final Draft.

B. Engineer: Engage a licensed Engineering Professional acceptable to the owner to perform dynamic analysis of the Blast Resistant Panels. The Blast Engineer shall have a minimum of 5 years experience in blast resistant design and demonstrable experience designing blast resistant concrete systems to comparable load requirements in the past 18 months.

C. Fabricators of precast concrete panels and windows must coordinate work to ensure the adequacy of the precast panels to support the blast loads tributary to the glass and the anchorage forces from the window systems. Should the glazing design change then the panels must be checked for the capacity of the revised glass type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver prefabricated units to Project as completely assembled units, ready for anchorage into supporting structure, and for interfacing with other work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Precast Concrete: Use normal weight concrete with a compressive strength of 5000 psi or greater.
   1. Reinforcement: If dynamic analysis is used, the compressive strength of concrete and yield strength of reinforcement may be increased to account for dynamic strain rate effects as follows:
      a. Reinforcing Steel: For fy = 60 ksi, the yield strength may be increased by a factor of 1.30.
      b. Concrete: Compressive strength may be increased by a factor of 1.17.

---END---

SECTION 03 45 05
PRECAST ARCHITECTURAL SITE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section Includes:

1. The work performed under this section includes all labor, material, equipment, related services, and supervision required for the manufacture and installation of the architectural precast site concrete work shown on the Landscape Series drawings.
   a. Architectural precast concrete benches.
   b. Two colors required; See Section 09 06 00, Schedule for Finishes.

1.2 RELATED WORK (Items not included in this Project Manual are available from the Construction Manager upon request)

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Mockup: Section 01 43 39 – Mockups.

C. Exterior Wind Enclosure Requirements: Section 01 83 16.13.

D. Concrete: Section 03 30 09, CAST-IN-PLACE CONCRETE:

E. Size, type and color of aggregate for exposed aggregate finish and matrix color: Section 09 06 00, Schedule for Finishes.

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. Has sufficient production capacity to produce required units without delaying work.

B. Erector Qualifications:
   1. Regularly engaged for at least 5 years in erection of architectural precast concrete units similar to those required on this project.

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. Standards: Fabricator to manufacture and install architectural precast concrete to meet requirements of ACI 318.

E. Qualifications of Welders and Tackers: Certified in accordance with AWS D1.1/D.1.1M, "Structural Welding Code - Steel"; and AWS D1.4 "Structural Welding Code - Reinforcing Steel" as applicable.

F. Sample Panels: After sample approval and before fabricating units, produce a minimum of two sample panels approximately[18 inches square in size for review by Resident Engineer. Incorporate full scale details of architectural features, finishes, textures, and transitions in the sample panels. Approved sample panel may be used for mockup and range sample.

1. Locate panels where indicated or, if not indicated, as directed by Resident Engineer.
2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
3. After acceptance of repair technique, maintain one sample panel at the manufacturer's plant and one at the project site in an undisturbed condition as a standard for judging the completed work.
4. Demolish and remove sample panels only when directed.

G. Range Samples: After sample panel approval and before production of units, produce a minimum of three samples, approximately18 inches square in size, representing anticipated range of color and texture on project's units. Following range sample acceptance by the Resident Engineer, maintain samples at the manufacturer's plant as color and texture acceptability reference.

H. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Louisiana and who has a minimum of 10 years experience providing engineering services of the kind indicated for precast architectural concrete.

I. Mockups: After sample approval but before production of units, construct full sized mockup of bench 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 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.
2. Notify Resident Engineer in advance of dates and times when mockups will be constructed.
3. Obtain Resident Engineer'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. Mockup may be used in completed work.

1.4 DESIGN REQUIREMENTS

A. The Drawings show aesthetic design intent. Products provided must conform to design intent shown and performance levels specified. The drawings and specifications are complementary regarding the aesthetic design intent.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. 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.

C. Design Mixes: For each concrete mix along with compressive strength and water-absorption tests.

D. Shop Drawings: Detail fabrication of units.

E. Samples: Samples for each facing unit required, showing the full range of color and texture expected. Supply sketch of each corner or special shape with dimensions. Supply sample showing color and texture of joint treatment.

1. Submit for approval samples representative of finished exposed face showing typical range of finishes, color, and texture of exposed surfaces of units; before production of job mock-up specified in Quality Assurance.
2. Sample Size: Minimum 18 inch x 18 inch of appropriate thickness, representative of the proposed finished product.

F. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with specifications, concrete mix designs, compressive strength tests on concrete, and water absorption tests on units.

1. Color Additive: If used, submit documentation proposed material complies with ASTM C 979.

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

1. Concrete materials.
2. Reinforcing materials.
3. Admixtures.
4. Bearing pads.

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.

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 resist abnormal degradation due to exterior exposure, 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 (Latest edition unless otherwise noted)

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):

1. A184/A184M Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
2. A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
3. A497 Steel Welded Wire Reinforcement, Deformed, for Concrete
4. A615/A615M-04a Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
5. C33 Concrete Aggregates
6. C40 Organic Impurities in Fine Aggregate for Concrete
7. C150 Portland Cement
8. C260 Air-Entraining Admixtures for Concrete
9. C330 Lightweight Aggregates for Structural Concrete
10. C373) Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
11. C494/C494M Chemical Admixtures for Concrete
12. C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
13. C979 Pigments for Integrally Colored Concrete
14. C989 Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
15. C1017/C1017M Chemical Admixtures for Use in Producing Flowing Concrete
16. C1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
17. C1218/C1218M Test Method for Water-Soluble Chloride in Mortar and Concrete
18. C1240 Silica Fume Used in Cementitious Mixtures

C. American Concrete Institute (ACI):

1. ACI 211.1 Selecting Proportions for Normal, Heavyweight and Mass Concrete (Reapproved 2002)
2. ACI 318/318M Building Code Requirements for Structural Concrete

D. American Association of State Highway and Transportation Officials

1. AASHTO LFRD LRFD Bridge Design Specifications, U.S., 3rd Edition
2. AASHTO M251 Elastomeric Bearings

E. Precast/Prestressed Concrete Institute (PCI):

1. MNL-117 Quality Control for Plants and Production of Architectural Precast Concrete Products
2. MNL-120 Design Handbook – Precast and Prestressed Concrete
3. MNL-127 Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products
4. MNL-135 Tolerance Manual for Precast and Prestressed Concrete Construction
5. TR-6 Interim Guidelines for the Use of Self-Consolidating Concrete

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. Steel Bar Mats: ASTM A184/A184M, assembled with clips.

C. Plain-Steel Welded Wire Reinforcement: ASTM A185, fabricated from as-drawn steel wire into flat sheets.

D. Deformed-Steel Welded Wire Reinforcement: ASTM A497, flat sheet.

E. 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: Match design used for approved mockup.

b. Hard durable quartz, marble, granite, siliceous stone, limestone, or other aggregate, carefully graded from coarse to fine in proportions required to match approved samples.
c. 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 Architect..

a. Test sand for color value in accordance with ASTM C40. Sand producing darker than specified color standard is unacceptable.
b. Clean washed white silica sand.

D. 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.

E. 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 ACCESSORIES

A. Miscellaneous: All materials, tools, equipment, hardware, and devices required for complete installation.

B. Sand-Cement Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.

2.5 CONCRETE MIXES

A. Prepare design mixes to match approved mockup for each type of concrete required.

1. Limit use of fly ash and silica fume to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent 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. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.

F. 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.

G. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

2.6 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.

1. Form joints are not permitted on faces exposed to view in the finished work.
2. Edge and Corner Treatment: Uniformly rounded or chamfered as indicated on drawings.
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.

B. Manufacturing Procedures: In accordance with PCI MNL 117.

1. Benches: Sizes and profiles as shown.

C. 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.

D. Cast-in slots, voids, and other features in units as indicated.

E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabrication, placing, and supporting reinforcement.

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

2. Place reinforcing steel to maintain at least 3/4 inch minimum concrete cover. Increase cover requirements for reinforcing steel to1-1/2 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. Direct wire tie ends away from finished, exposed concrete surfaces.

3. 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. Provide a single design mix throughout the entire thickness of bench.

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. Pickup points not permitted at panel edges or faces exposed to view or weather.

I. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

J. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

2.7 FABRICATION TOLERANCES

A. Fabricate benches with tolerances meeting PCI MNL 135.

2.8 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 mockups and as follows:

B. Panel Face Types: Appearance including color, mix, profile, and texture.

1. Exposed Exterior Surfaces: See Section 09 09 00, Schedule for Finishes. Light sandblast. Match finish of approved mockup panels.

2. Exposed Vertical Interior Surfaces: Smooth float finish after striking surfaces flush to form finish lines.
3. Concealed Surfaces: As cast finish using smooth, non-porous molds.

2.9 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. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

C. Testing: If there is evidence that the concrete strength of precast concrete units may be deficient, precast architectural concrete fabricator 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 architectural 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 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.

2. 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 Architect and Resident Engineer reserve 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.

D. Keep quality control records available for the Architect and Resident Engineer upon request for a minimum of 4 years after final acceptance. These records shall include mix designs, test reports, inspection reports, member identification numbers along with date cast, shipping records and erection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine supporting 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.

B. Do not install units until supporting cast-in place concrete has attained minimum allowable design strength.

3.2 INSTALLATION

A. Benches: Loose set benches in accurate locations.
   1. Where benches rock or tip due to imperfections in slab or bench; set in mortar bed with plastic shims as needed.

3.3 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.

3.4 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. Remove and replace damaged units when repairs do not meet requirements.

3.5 CLEANING

A. Clean all surfaces of precast concrete to be exposed to view, as necessary, prior to shipping.

B. Clean mortar and other deleterious and foreign material from precast surfaces and adjacent materials immediately.

C. Clean exposed surfaces of precast concrete units after erection to remove markings, dirt, stains, and foreign material.

   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.

- - - E N D - - -

SECTION 03 52 00
LIGHTWEIGHT CONCRETE ROOF INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section Includes: Provide lightweight insulating concrete (LWIC) to be installed as part of the membrane roof assembly consisting of: the following:
1. Composite board and cementitious roof insulation system.
2. Vapor retarder (See Section 07 52 16. Noted here for sequence purpose).
3. Accessories.

B. Related Sections:
1. Concrete Decks: Section 03 30 09.
2. SBS Modified Bituminous Roofing: Section 07 52 16.
3. Air Weather Barrier (AWB) in perimeter walls: Section 07 27 30.

1.2 REFERENCE STANDARDS (Latest edition unless otherwise noted.)

A. American Society for Testing and Materials (ASTM):

C 150	Portland Cement.
C 177	Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
C 518	Test Method for Steady-State Heat Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
C 578	Preformed, Cellular Polystyrene Thermal Insulation.
C 796	Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam.
C 1363	Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.

B. Factory Mutual (FM):

4450	Approval Standard for Class 1 Insulated Steel Deck Roofs – with Supplements

C. Roof Insulation Committee of the Thermal Insulation Manufacturers Assoc. (RIC/TIMA):

281-1	Conditioning Procedure Bulletin.

D. Underwriters Laboratory (UL):

1.3 SYSTEM DESCRIPTION

A. Roofing system is conventional type with insulation located below the membrane.

B. Slope:

1. Typical: Flat structure.
2. Remaining slope required: Minimum 1/4 inch per foot.

C. Roof Assembly:
1. Roof Membrane: Fully Adhered Membrane System specified elsewhere.
2. Structure: deck with no slope.
3. All materials located below roof membrane and above deck.
4. Vapor retarder is applied directly to structural concrete deck with LWIC installed on it.
5. Insulation: Required at all roofs over heated spaces except at Dixie building. Insulation not required at roofs over exterior unheated spaces except as needed for proper drainage and substrate for roof membrane.
6. Membrane fully adhered to insulation system.
7. Assembly Thickness: Some areas are limited to total thickness of insulation assembly. These areas are noted on drawings. Notify Architect where height limitations conflict with slope requirements or other provision of this specification.

D. Design Requirements: Maximum thickness of insulation assembly is as follows:
1. Roof Areas with Coping: No limit except top of assembly to be not higher than 8 inches below bottom of coping.

E. Performance Criteria:
1. Fire Hazard Classification:
a. UL listed as acceptable component for a Class 1 steel deck assembly.
b. UL listed for use under Class A, B, and C Roof Coverings.
2. Wind Rating: Equivalent to that specified elsewhere for membrane roofing.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

B. Product Data: Submit with membrane roofing specified elsewhere, manufacturer's printed literature describing all materials requirements.
1. Include fire-ratings and wind uplift ratings for system.
2. Specifications for mixing, placing, curing and protection of insulating concrete

C. Shop Drawings: Show roof plan.
1. Slope: Show amount of slope in inches per foot and total rise in inches above substrate.

D. Samples: Submit for approval two samples of system proposed for use; nominal 12 inch x 12 inch size.

E. Certificates: Foam manufacturer's written certification that applicator has equipment and training to provide a satisfactory installation.

1.5 QUALITY ASSURANCE

A. Materials and assemblies shall be:
1. Approved by Architect.
2. Approved or manufactured by roof membrane system manufacturer, and approved by roof insulation manufacturer, for conditions, intended purpose, and required assemblies.

B. Installer: Approved by the Lightweight Concrete Roof Insulation Manufacturer

C. Comply with recommendations of materials manufacturer.

D. Insulation to comply with the following::
1. "Aged" Materials: RIC/TIMA Conditioning Procedure Bulletin 281-1.

E. Adhered Assemblies: All field-bonded board products furnishing wind resistance for itself or other roof components, including roof membrane, must be supplied or approved by the membrane manufacturer for single-source responsibility. *** OPTION

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact.

B. Store roof insulation materials in trailers or in buildings in dry location.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Install roof insulation only when satisfactory conditions prevail.
1. Apply no insulation or roofing materials when ice or excessive moisture in is present on roof deck.
2. Temperature: Insulating concrete may be placed when temperatures are 32 degrees F and rising.
a. If colder temperatures are anticipated, the Applicator shall take suitable precautions for the installation of an acceptable deck.
b. The roofing membrane application must be coordinated with the insulating concrete roof system to avoid prolonged exposure of the deck.

B. Do not expose insulation below membrane to weather. Apply no more insulation than can and will be completely covered with finished roofing on same day.

1.8 WARRANTY

A. Warranty: Roofing system, including insulation, is subject to terms of warranty specified in Section 07 52 16.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Subject to compliance with requirements, manufacturers of products that may be incorporated into the Work include, but are not limited to, the following:
1. Basis of Design: Celcore Cellular Concrete by Celcore Inc.
2. Elastizell.

2.2 INSULATING CONCRETE

A. Insulating concrete is a slurry of cement, water, and foaming agent at a specified density.

B. Materials:
1. Cement: Portland cement, ASTM C150 - Type I,or III.
2. Foaming Agent: ASTM C 869.
3. Admixtures: None permitted unless specifically approved by the Manufacturer.
   a. Pozzolans and other cementitious materials.
   b. Admixtures for water reducing and set acceleration. A superplasticizer, compatible with the expansion material may be used to reduce the mix water.
4. Reinforcement: The insulating concrete may contain non-metallic fibers (3/4" long polyester) in minimum quantities of 1#/cubic yard of insulating concrete in lieu of Keydeck mesh requirements.
5. Water: Potable.

C. Mix: As recommended by manufacturer to obtain the physical properties listed below.

D. Physical Properties: Test per ASTM C 495 for below properties.

Dry Density	42-50 pcf
Minimum Compressive Strength	300 psi

2.3 INSULATION BOARD

A. Expanded Polystyrene (EPS):
1. Minimum 1.0 pcf; ASTM C578, Type I.
2. Thicknesses: Shown on the Drawings or as needed for slope or R value as required (up to 12" thick).
3. Configuration: Minimum of six 3" diameter bond holes for each 8 square feet of board for bonding; approximately 3% open area.

2.4 VAPOR RETARDER

A. Provided under Section 07 52 16, SBS Modified Bituminous Roofing.

2.5 ACCESSORIES

A. Cants and Nailers: Treated wood nailers and blocking furnished and installed under Section 06 10 00 - Rough Carpentry.

B. Other: As required for complete installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate and conditions under which work of this Section is to be performed. Notify Architect in writing of unsatisfactory conditions. Proceed only after conditions have been corrected in manner acceptable to installer.

B. Clear the deck of all standing water, dirt, debris, ice, and contaminants detrimental to bond.

C. Lay out the roof grades prior to placing the insulating concrete roof system.

D. Do not start until curbs, sleeves, edge venting, or other penetration forms are completed and vapor retarder is in place.

E. Installation of work constitutes installer's acceptance of substrate.

3.2 INSTALLATION

A. Install roof insulation in accordance with manufacturer's printed instructions and approved shop drawings to insure proper drainage, the required insulation value, and the published fire and uplift ratings.
1. Cold Weather Concreting: ACI 306R.
2. Hot Weather Concreting: ACI 305R.

B. Install roof insulation over completed vapor retarder, specified elsewhere.

C. Mixing and Placing: Mix insulating concrete in accordance with ACI 523.1R or manufacturer's printed specifications where more demanding.
1. Mix insulating concrete in Manufacturer approved equipment and pump into place.
2. Slurry coats, double casting, and two-density casting are acceptable methods of installation.

D. Board Insulation:
1. Place in slurry coat and top with a minimum 2" of insulating concrete.
2. Install in a stair-stepped fashion.
3. Hold insulation board 3+" from the perimeter of the roof deck and all rooftop units.

E. Finishing: Screed insulating concrete to the proper thickness and slope with a surface free of ridges and sharp projections prior to installation of the roofing membrane.
1. Slope: ¼" / foot.
2. Depressions that create ponding are not acceptable.

F. Cure in accordance with ACI 308R, or manufacturer's specification where more demanding.

3.3 FIELD QUALITY CONTROL

A. Testing shall be conducted and reported by the Manufacturer

B. Density Testing:

1. Check the cast density on the roof deck and adjust the mix to obtain the required cast density.
2. Sample minimum of 4 test specimens (3" x 6" cylinders) the point of placement daily or for each 100 yards of material placed.
3. Protect samples from damage and temperature extremes and test accordingly to ASTM C796.
4. Do not oven-dry samples prior to compressive testing.
5. Testing shall be conducted and reported by the Manufacturer.

C. Pull-Out Testing: Provide pull-out testing where mechanical fasteners are required as a component of the specified membrane roofing system.
   1. Fasteners pull-out test for roofing: Resist a pull out force when driven into cured insulating concrete.
      a. Pull-Out Force: Not less than required by roof membrane manufacturer for uplift force for design wind load. Minimum 14 kg (30 pound)
   2. Perform roof fastener pull-out test for each 160 square meters (10 squares) or not less than 3 tests whichever is greater.
   3. Patch test pull out areas after fastener is removed.
   4. Selection of test location and witness of tests by Resident Engineer//.

3.4 CLEAN-UP AND WORK STOPPAGE PROCEDURES

A. Completion: Begin roofing when the insulating concrete roof system can withstand construction traffic.
   1. This is usually 2 to 5 days after the deck has been placed. The roof deck should not be left exposed for longer than 5 to 7 days.
   2. Provide temporary tarpaulins as needed to protect insulating concrete from rain entering the roof deck after the deck is cast and finished.
   3. Consult the roofing manufacturer's literature for their recommended base sheet nailing pattern for attaching the base sheet to the insulating concrete roof system.

B. Provide water cut-offs at perimeters, sealed to substrate with suitable mastic; Remove cut-offs when subsequent work starts.

C. Clean-up: Remove unused building materials from jobsite and leave completed roof deck ready to receive membrane roofing specified elsewhere.

END OF SECTION

SECTION 03 54 00
CAST UNDERLAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fill low points of structural floors for the following:
      a. Existing Dixie floor slabs as needed to match elevation of new slabs.
      b. At rail-mounted markerboards
      c. Recessed entry grilles.
      d. Other locations: As needed.
   2. Provide fill where required to level floor and at other conditions where existing floor defects require patching or filling.
   3. Coordinate requirements and submit a descriptive list of floor areas included in bid.
   4. Slab preparation.

B. Field measure existing Dixie floor slabs

C. Unit Price: Submit unit price in dollars per cubic foot for cost of installed cast underlayment using the formula below for Bid. Unit price will be used to adjust Contract Sum, up or down, based on actual quantity of work provided.
   1. Unit Price x 600 cubic feet = Bid

D. Related Sections:
   1. Floor Coverings: Division 9.
   2. Custom Rail-Mounted Markerboards: Section 10 11 16
   3. Entrance Mats: Section 12 48 13.
   4. Vapor retarder for slab on grade conditions: 07 26 14 - Topical Vapor Retarders.

1.2 PERFORMANCE REQUIREMENTS

A. Floor at Rail-Mounted Markerboards: Provide level floor from wall to wall and minimum 12 inches wide on centerline of operable walls with a tolerance not to exceed plus or minus 1/8 inch in 10 feet, non-cumulative.

B. Recess at Entry Mats: Bring floor to required heights so entry mats are flush with adjacent finish floor surface.

C. Leveling material must be capable of feathering edges to 0 inch thickness.

D. Minimum compressive strength 4,000 psi in 28 days.

E. No shrinkage, cracking, spalling or loss of bond to substrate.

F. Suitable substrate for floor coverings and finishes scheduled.

G. Water resistant; no gypsum or asbestos components.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23.

B. Product Data: Manufacturer's data describing product, physical characteristics, recommended applications; applications not recommended; thickness limitations; and installation description.

1.4 QUALITY ASSURANCE

A. Installer: Specialist in the installation of materials specified and regularly engaged in the installation of same; qualified in, and familiar with, manufacturer's recommendations for the installation of the materials.

B. Manufacturer's Representative: See FIELD QUALITY CONTROL in Part 3.

1.5 JOB CONDITIONS

A. Environmental Conditions: Temperature, ventilation, time requirements and other factors effecting installation as recommended by manufacturer.

B. Cementitious underlayment is subject to water damage before full cure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide conforming products from one of the following:
1. Ardex, Inc., Coraopolis (Pittsburgh), PA.
2. BASF, Florham Park, N.J www.basf.com.
3. Sika Corporation, Lyndhurst, NJ.
4. Mapei, Deerfield, FL.
5. Dependable Chemical Co., Rocky River, OH.

2.2 MATERIALS

A. General:
1. See PERFORMANCE REQUIREMENTS in Part 1 above.
2. Cement-Based Products: Systems utilize hydraulic mortar with "chemical" cure technology and are not dependant on evaporation for cure.

B. Self-Leveling Underlayment: "Ultraplan 1" by Mapei; ; High strength, fast setting, non-shrink underlayment for leveling floors in designated areas.
1. Fill Range: Feather-edge to 1-1/2 inches.

C. Sloped Underlayment: "Mapecem Premix" by Mapei; High strength, fast setting, non-shrink underlayment for building slopes or filling to non-level surfaces in designated areas.
1. Fill Range: ¼ to 4 inches.

D. Skim-Coat: "Mapei Finefinish", by Mapei; Fast-setting, polymer-modified, cement based compound for finishing and smoothing fully cured substrates.
   1. Fill Range: Feather-edge to ¼ inch.

E. Primer: Non-flammable type as recommended by underlayment manufacturer. Not required where applied over membrane waterproofing.
   1. Not required where applied over membrane waterproofing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive Cementious Underlayment and verify that conditions are satisfactory for the installation. Substrate must be solid, clean, dry, and free from oil, wax, grease, curing compounds, latex compounds, gypsum, asphalt or other foreign matter.

B. Notify Resident Engineer of any conditions deemed unsatisfactory for the installation.

C. Installation of work under this Section is understood as acceptance of the substrates as satisfactory.

3.2 PREPARATION

A. Clean concrete slab using abrasive steel shot process; see PREPARATION under Section 01 73 00 - Execution.

B. Prime existing substrate using materials recommended by underlayment manufacturer

C. Verify that temperature control is provided to meet requirements of underlayment manufacturer.

3.3 INSTALLATION

A. Install all materials in accordance with manufacturer's printed instructions.

B. Where use of aggregate is recommended for thick fills, provide finish layer without aggregate or use skim-coat product to achieve smooth finish

C. At operable partitions, transition leveled area to adjacent floor so that slope does not exceed 1/8 inch per foot.

3.4 FIELD QUALITY CONTROL

A. Tolerances:
   1. Typical: 1/8 inch in 10 feet.
   2. Operable Walls: See PERFORMANCE REQUIREMENTS in Part 1.

B. Manufacturer to furnish technical representative to assist and instruct proper procedures for inspection, mixes, mixing, application, and protection requirements.

3.5 PROTECTION

A. Protect installed Cementitious Underlayment work to prevent damage from work of other trades, including foot traffic and equipment.

END OF SECTION