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USACE / NAVFAC / AFCESA / NASA **UFGS-03 45 00 (November 2011)**

Preparing Activity: NAVFAC **Superseding UFGS-03 45 00 (August 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2012
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PRECAST ARCHITECTURAL CONCRETE
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NOTE: This guide specification covers the requirements for precast concrete wall panels with normal-weight aggregate portland cement concrete, conventional reinforcing, and smooth surface or exposed aggregate facing.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: The panels specified are intended for attachment of the building framing system at each floor elevation and at the roof elevation. The panels may be provided with built-in anchorage devices for the attachment of thermal insulation blankets to the interior face of the wall panels and for the attachment of metal flashing after the wall panels have been installed.
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Note: Drawings should include a complete design indicating the character of the work to be performed and the following:

1. Location and details of wall panels, showing all

dimensions, and size and type of reinforcement.

2. Details of joints between wall panel units, showing sealant or gasket shape, dimensions, and location.

3. Details showing both the location and type of anchorage devices of the panels to the building framing system and the connection of other materials (reglets, insulation nailers, etc.) to the panels. Indicate gravity loads, live loads, dynamic loads, and stresses inherent in the structure for the manufacturer to provide embedded panel anchorage.

4. Locations where flashing reglets are required.

5. Locations of inserts (wedge type, slotted type, etc.) cast into the concrete panels.

6. Location of each type of surface finish, with details of transitions between different types of surface finishes.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 117	(2010) Specifications for Tolerances for Concrete Construction and Materials and Commentary

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 301	(2010) Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305.1	(2006) Specification for Hot Weather Concreting
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2011; Errata 2011) Building Code Requirements for Structural Concrete and Commentary
ACI 318M	(2011) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2010) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C2	(2003) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes

ASME INTERNATIONAL (ASME)

ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A27/A27M	(2010) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A283/A283M	(2003; R 2007) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A416/A416M	(2010) Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A449	(2010) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A496/A496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A497/A497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A706/A706M	(2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A966/A966M	(2008; R 2012) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM B370	(2011e1) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C1088	(2011) Standard Specification for Thin Veneer Brick Units Made From Clay or Shale
ASTM C109/C109M	(2011b) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C114	(2011b) Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C115	(2010) Standard Test Method for Fineness of Portland Cement by the Turbidimeter
ASTM C117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2011) Standard Test Method for Lightweight Particles in Aggregate
ASTM C125	(2011b) Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C127	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2010b) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete

ASTM C142/C142M	(2010) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2010a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2011) Standard Specification for Portland Cement
ASTM C151/C151M	(2009) Standard Test Method for Autoclave Expansion of Hydraulic Cement
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C183	(2008) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C185	(2008) Standard Test Method for Air Content of Hydraulic Cement Mortar
ASTM C186	(2005) Standard Test Method for Heat of Hydration of Hydraulic Cement
ASTM C191	(2008) Standard Test Method for Time of Setting Hydraulic Cement by Vicat Needle
ASTM C192/C192M	(2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C204	(2011) Standard Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C232/C232M	(2009) Standard Test Methods for Bleeding of Concrete
ASTM C233/C233M	(2011) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C266	(2008e1) Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C289	(2007) Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C29/C29M	(2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in

	Aggregate
ASTM C31/C31M	(2010) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2011a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C403/C403M	(2008) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C42/C42M	(2012) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C451	(2008) Standard Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
ASTM C494/C494M	(2011) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2009) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(1997; R 2004) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2011) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2012) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C70	(2006) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78/C78M	(2010) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	(2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2012) Standard Specification for Ready-Mixed Concrete

ASTM C989/C989M	(2011) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1149	(2007) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D3744/D3744M	(2011a) Standard Test Method for Aggregate Durability Index
ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D746	(2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D75/D75M	(2009) Standard Practice for Sampling Aggregates

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition
PCI MNL-117	(1996) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, 3rd Edition
PCI MNL-122	(2007) Architectural Precast Concrete, 3rd Edition

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within

the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Precast concrete wall panel[; G][; G, [_____]]

[Submit formwork shop drawings and panel elevations detailing the location of embedded brick work.]

[1. Panel Sizes]
[2. Joint Locations]
[3. Joint Widths]
[4. Brick Coursing]
[5. Brick Coursing Alignment Across Panel Joints]
[6. Reveal and False-joint Locations and Dimensions]

[Architect/Engineer review of shop drawings is for general conformance with design concept and project requirements only, and does not imply approval or any variance from the Contract Documents.]

SD-03 Product Data

Cast-in embedded items and connectors[; G][; G, [_____]]

Connection devices[; G][; G, [_____]]

[1. Brick Color chips representing color and size of each brick type to be used.]
[2. Form Liner Samples representing all brick inlay form liners which will be used.]
[3. Bond breaker sample on brick chip representing bond breaker which will be used.]
[4. Printed product data and installation instructions for brick inlay form liner system, and brick.]

SD-04 Samples

Concrete wall panel surface finishing[; G][; G, [_____]]

SD-05 Design Data

Precast concrete wall panel design calculations[; G][; G, [_____]]

Contractor-furnished mix design[; G][; G, [_____]]

Concrete mix design for repair of surface defects[; G][; G, [_____]]

Precast concrete wall panel connection and embedment design calculations[; G][; G, [_____]]

SD-06 Test Reports

Strength tests[; G][; G, [_____]]

Submit commercial testing results in accordance with PCI MNL-117 and as required in paragraph entitled "Sampling and Testing."

SD-08 Manufacturer's Instructions

Installation of precast concrete wall panel[; G][; G, [_____]]

Cleaning of wall panel[; G][; G, [_____]]

Include precast concrete wall panel manufacturer's written recommendations for installation and cleaning.

SD-11 Closeout Submittals

Concrete batch ticket information[; G][; G, [_____]]

Manufacturer's Qualifications

Calculations

Mix Design

Precast Concrete Manufacturer

Wall-panel Installer

Concrete

Exposed-to-View Concrete

Backing Concrete

Slump

Air Content

Compressive Strength

Mock-Up

Pre-Installation Meeting

Tolerances

Portland Cement

Exposed-to-View Finished Surfaces

Air-Entrained Admixtures

Finish Aggregate

Gasket

Miscellaneous Architectural Precast Concrete Systems

Thin Brick Veneer

Erection

1.3 MODIFICATION OF REFERENCES

In the referenced ACI and PCI publications, consider the advisory provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.4 GENERAL REQUIREMENTS

Precast concrete units must be designed and fabricated by an experienced and acceptable precast concrete manufacturer certified under the PCI Plant Certification Program. The manufacturer needs to have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. The Contractor must submit a statement detailing the Manufacturer's Qualifications as specified in the Submittals paragraph. Coordinate precast work with the work of other trades.

1.5 DESIGN

1.5.1 Standards and Loads

****
NOTE: Design loads will be shown on the drawings. Criteria for design loads are contained in ASCE 7 and EI 01S010. The differential temperature of 89 degrees C 160 degrees F is based on extreme values of 40 degrees C 40 degrees F below zero to 49 degrees C 120 degrees F above zero; it should be used for computing volume changes due to temperature variations. Other values, greater or smaller, should be used instead whenever justified by climatic conditions at the jobsite. For in-house design delete all references to design by others.
****

Precast unit design must conform to ASCE 7, ACI 318M ACI 318 and PCI MNL-122. Indicate design loads for precast concrete on the drawings. A differential temperature of [89] [_____] degrees C [192] [_____] degrees F, between interior and exterior faces of the units, must be considered in the

design. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection must be accounted for in the design.

1.5.2 Connections

Connection of units to other members, or to other units must be of the type and configuration indicated. The design and sizing of connections for all design loads will be completed by the Contractor.

1.5.3 Concrete Strength

Precast concrete units must have a 28-day compressive strength of 34 MPa 5000 psi.

1.5.4 Concrete Proportion

Base the selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportion using the same type and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete and admixtures containing chloride ions, nitrates, or other substances that are corrosive will not be used in prestressed concrete.

1.5.5 Calculations

Calculations for design of members and connections not shown must be made by a professional engineer experienced in the design of precast architectural concrete. Calculation will include the analysis of member for lifting stresses and the sizing of the lifting inserts.

1.5.6 Mix Design

The Contractor must submit the mix design formula giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, prior to commencing operations. Submit certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, and aggregates. The statement must be accompanied by test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. Make no substitutions without additional tests to verify that the concrete properties are satisfactory.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials, except for wall panels, to the project site in the original, unbroken packages or containers, each bearing a label clearly identifying manufacturer's name, brand name, weight or volume, and other pertinent information. Store packaged materials, and materials in containers, in a weathertight and dry place until ready for use.

Store products in manufacturer's unopened packaging in dry storage area, with ambient temperature between minus 1 degree C 30 degrees F and 41 degrees C 120 degrees F, until installation.

1.7 STORAGE AND INSPECTION AT MANUFACTURER'S PLANT

Protect precast units temporarily stored at the manufacturer's plant from damage in accordance with [PCI MNL-116] [and] [PCI MNL-117 and PCI MNL-122]. Immediately prior to shipment to the jobsite, all precast concrete units must be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality will include, but will not be limited to, the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing. Replace or repair all defective precast concrete units as approved.

1.8 PLANT INSPECTION

[At the option of the Contracting Officer, precast units may be inspected.] [Precast units must be inspected by the QC representative prior to being transported to the job site.] The Contractor is to give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.8.1 PCI Quality Certifications

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NOTE: For normal routine projects, use the first paragraph. For complex or large precast/prestressed projects, use the second paragraph. Note that use of the second paragraph may limit competition. Verify the availability of certified PCI precasters in the bidding area. Do not use for NAVFAC LANT.
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[1.8.1.1 Product Quality Control

PCI MNL-116 for PCI enrolled plants. Where panels are manufactured by specialist in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

][1.8.1.2 Product Quality Control

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NOTE: Category C1: Mild steel reinforced precast concrete element. Category C2: Prestress hollow core and repetitive products. Category C3: Prestressed Straight Strand Structural Members. Category C4: Prestressed Draped Strand Structural Members.
****

Plants must be certified by the PCI Plant Certification Program for Category [A1] [A2] work, or Architectural Precast Association (APA) certification.

]1.9 QUALIFICATIONS FOR PRECAST CONCRETE MANUFACTURER

Panels are to be manufactured by an organization experienced in the

manufacture of precast concrete panels.

Submit a letter of reference for the manufacturer giving the qualifications of personnel, location of plant, concrete batching facilities, manufacturing equipment and facilities, list of projects similar to specified work, and other information as may be required by the Contracting Officer.

1.10 QUALIFICATIONS FOR WALL-PANEL INSTALLER

Panels must be installed by an organization experienced in the installation of precast wall panels.

Submit a letter of reference for the installer giving the qualifications of personnel, handling and erection equipment, lists of projects similar to specified work, and other information as may be required by the Contracting Officer.

1.11 CONCRETE SAMPLING AND TESTING

1.11.1 Test for Concrete Materials

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NOTE: Delete the following where required by the project.
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Sample and test concrete materials proposed for use in the work as follows:

MATERIALS	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Aggregate	Sampling sieve analysis, calculating fineness modulus	ASTM D75/D75M ASTM C136 ASTM C125	One for each material source and grading size
	Amount of material passing 75 micrometer No. 200 sieve	ASTM C117	
	Amount of friable particles	ASTM C142/C142M	
	Amount of organic impurities	ASTM C40	
	Amount of coal and lignite	ASTM C123/C123M	
	Magnesium sulfate soundness test	ASTM C88	

MATERIALS	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Aggregate durability	ASTM D3744/D3744M	
	Specific gravity of fine aggregate	ASTM C128	
	Specific gravity of course aggregates	ASTM C127	
	Resistance to abrasion of small size course aggregate	ASTM C131 or ASTM C535	
	Potential reactivity to alkalis	ASTM C289	
Portland Cement	Sampling	ASTM C183	One for each material source, type and color
	Chemical analysis	ASTM C114	
	Fineness	ASTM C115 or ASTM C204	
	Autoclave expansion time of setting	ASTM C151/C151M, ASTM C191 or ASTM C266	
	Air Content of mortar	ASTM C185	
	Compressive strength	ASTM C109/C109M	
	Heat of hydration	ASTM C186	
	False set	ASTM C451	

MATERIALS	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Air-entraining admixture using air-entrained concrete made of the proposed concrete materials	Materials for test	ASTM C233/C233M	One set of tests for each type and color of portland cement proposed for use
	Number of specimens	ASTM C233/C233M, Table 1	
	Bleeding	ASTM C232/C232M	
	Time of setting	ASTM C403/C403M and ASTM C233/C233M	
	Compressive strength test specimen	ASTM C192/C192M and ASTM C233/C233M	
	Compressive strength test at 3, 7 and 28 calendar days	ASTM C39/C39M and ASTM C233/C233M	

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NOTE: Water absorption test is a relative measure of the ability of different concretes to resist dirt adhesion, staining from soft aggregates, or other phenomena that may lead to non-uniformity and unsightliness.

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MATERIALS	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete made of the proposed concrete materials	Water absorption	As specified	Three 100 by 200 mm 4 by 8 inch cylinders or 100 mm 4 inch cube concrete specimens for each type of mixture required

Submit reports for each material sampled and tested prior to the start of work. Reports must contain the project name and number, date, name of Contractor, name of precast wall panel manufacturer, name of concrete testing service, source of concrete aggregates, generic name of aggregate, and values specified.

1.11.2 Concrete Design Mixes

Concrete design mix for concrete, including Exposed-to-View Concrete facing mixture and Backing Concrete mixture, must be determined and tested as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Specific gravity and absorption of fine aggregate	ASTM C128	As required for the concrete aggregates
Specific gravity and absorption of course aggregate	ASTM C127	
Moisture content of both fine and coarse aggregate	ASTM C70 and ASTM C566	
Dry-rodded unit weight of course aggregate	ASTM C29/C29M	
Trial mixes using at least three different water/cement ratios, minimum allowable cement content and maximum allowable slump; all with air-entrainment	ACI 211.1	As required to determine the concrete mix having the properties specified

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Making and curing concrete specimens in the laboratory	ASTM C192/C192M	Two sets of three specimens for each design mix
Sampling fresh concrete in the laboratory	ASTM C192/C192M	One for each set of design mix specimens
Slump	ASTM C143/C143M ACI 211.1	
Air Content	ASTM C231/C231M	
Yield	ASTM C138/C138M	
Compressive Strength	ASTM C39/C39M	Three specimens tested at 7 calendar days and three specimens tested at 28 calendar days

From the results of the tests, plot a curve for each concrete mixture, showing the relationships between water/cement ratios and compressive strengths. Maximum permissible water/cement ratio must be that value not exceeding the maximum water/cement ratio specified, indicated by the curve to produce a design minimum laboratory compressive strength at 28 calendar days not less than that specified.

Submit report of the design mix for both exposed-to-view facing mixture and backing mixture for approval at least 15 calendar days prior to start of fabricating panels. Report is to contain the project name and number, date, name of Contractor, name of precast concrete wall panel manufacturer, name of concrete testing service, use of concrete mixture (facing or backing), source of concrete aggregates for each mixture, manufacturer and brand name of manufactured materials, the exact proportions of each concrete mix, the concrete properties specified, and the test results for each requirement specified for the concrete design mixes.

1.11.3 Quality Control Testing During Panel Fabrication

Sample and test concrete for quality control during fabrication as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Sampling fresh concrete	ASTM C172/C172M except modified for slump per ASTM C94/C94M	As required for each test

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Slump test	ASTM C143/C143M	One for each concrete load at point of discharge and one for each set of compressive strength tests
Air Content by pressure method	ASTM C231/C231M	One for each set of compressive strength tests
Compressive test specimens	ASTM C31/C31M	One set of six specimens for each Compressive Strength test

Compression test specimens may be either standard 150 by 300 millimeter 6 by 12 inch cylinders or 100 millimeter 4-inchcubes. Cubes may be molded individually or cut from slabs. Preparation and testing of cube specimens must be as nearly consistent with the test methods specified as possible, with the exception that the concrete will be placed in a single layer.

Curing of compression test specimens must be the same as the curing method used for the precast concrete wall panels until panels are stripped of forms and then standard moist cure will continue.

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete temperature		Each time a set of compression test specimens is made
Compressive strength tests	ASTM C39/C39M	One set of facing strength tests mix and one set of backing mix for every ten panels or fraction thereof cast in any one day; two specimens in each set tested at 7 calendar days; three specimens in each set tested at 28 calendar days, and one specimen in each set retained in reserve for testing if required

Submit test reports on the same day that tests are made.

Test results that fail to meet the value for any concrete property specified in "Quality of Concrete" must be noted in the report.

Reports for Compressive Strength tests need to contain the project name and number, date of concrete placement, name of Contractor, name of precast concrete wall panel manufacturer, name of concrete testing service, panel identification letter and number, use of concrete mixture (facing or backing), design compressive strength at 28 calendar days, concrete-mix proportions and materials, and compressive breaking strength and type of break.

If 100 millimeter 4-inch cubes are used for compressive strength specimens, average strength of the cubes at any test age must be multiplied by the factor of 0.8 to arrive at an estimate of the corresponding 150 by 300 millimeter 6 by 12 inch cylinder strength. Report both of these values .

1.12 QUALITY ASSURANCE

1.12.1 Wall Panel Drawings

a. Wall panel dimensions, cross-section, and edge details; location, size, and type of reinforcement, including reinforcement necessary for safe handling and erection of panels. Comply with ACI SP-66.

b. Layout, dimensions, and identification of each panel, corresponding to installation sequence.

c. Setting drawings, instructions, and directions for installation of concrete inserts.

d. Location and details of anchorage devices and lifting devices embedded in panels, and connection details to building framing system.

1.12.2 Design Calculations

Submit design calculations prepared and sealed by a registered professional engineer demonstrating compliance with indicated loading conditions.

1.12.3 Connection and Embedment Design Calculations

Submit design calculations prepared and sealed by a professional engineer demonstrating compliance with the indicating connection and embedment details.

1.12.4 Mix Designs

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Include a complete list of materials including type; brand; source and amount of cement[, fly ash, pozzolan, ground slag,] and admixtures; and applicable reference specifications.

1.12.5 Concrete Wall Panel Surface Finish Sample

Submit a concrete wall panel sample 300 mm by 300 mm 12 inches by 12 inches by approximately 40 mm 1 1/2 inches in thickness, to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of panel surfaces that will be concealed by other construction. [Obtain approval prior to submission of sample panels.]

1.12.6 Required Records

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.12.7 Mock-Up

Apply specified products to determine acceptability of appearance and optimum coverage rate required for application

1. Finish areas designated by Architect
2. Apply in accordance with manufacturer's instructions.
3. After materials have cured, water test surface to determine that sufficient water repellent has been applied.
4. Do not proceed with remaining work until mock-up is approved by Architect.

[Job Mock Up Panel: Minimum 1.2 meters 4 feet by 1.2 meters 4 feet]

[1. Incorporate edge, reveal, and brick coursing detail as shown on drawings.]
[2. Utilize full range of brick sizes, variance of brick size, general color of brick and variance in color and texture of brick.]
[3. Show clean, pressure washed brick and concrete surface]
[4. Utilize full range of color of concrete mortar joints]
[5. Maintain Mock Up for comparison with finished work]

Provide mock-up to establish that proposed materials and construction techniques provide acceptable visual effect. Materials used for mock-up should be those proposed for actual construction; retain samples of cement and aggregates used.

Provide mock-up sections of building and structures which typify the most difficult areas to build.

Do not proceed with remaining work until workmanship, color, and detail are approved by Architect. Modify mock-up area as required to produce acceptable work. After approval by Architect, transport mock-up to job-site and erect where directed by [Architect] [_____].

1.12.8 Pre-Installation Meeting

Hold a meeting at the job site with representative of the manufacturer and the applicator prior to application of water repellents. Notify the Owner and the Architect at least 3 days in advance of the time of the meeting.

1.13 Tolerances

Dimensions of the finished panel, at the time of erection in the structure, must conform to the tolerances for precast, non-prestressed elements in ACI 117, unless otherwise specified by the Architect.

PART 2 PRODUCTS

2.1 PROPERTIES OF CONCRETE

PROPERTY	VALUE
Design compressive strength at 28 calendar days, 150 by 300 millimeter cylinders	Not less than 34,500 kilopascal
Maximum aggregate size	As specified
Maximum water/cement ratio	16 liter per 43 kilogram sack of cement
Minimum cement content	7.5 43 kilogram sacks of cement per 0.76 cubic meter
Slump at point of concrete discharge	Not to exceed 50 millimeter
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 6 percent

PROPERTY	VALUE
Design compressive strength at 28 calendar days, 6 by 12 inch cylinders	Not less than 5,000 psi
Maximum aggregate size	As specified
Maximum water/cement ratio	4.25 gallons per 94-pound sack of cement
Minimum cement content	7.5 94-pound sacks sacks of cement per 0.76 cubic yard
Slump at point of concrete discharge	Not to exceed 2 inches
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 6 percent

2.2 CONCRETE

2.2.1 Contractor-Furnished Mix Design

****
NOTE: If gap-graded or one size architectural aggregates are used in a high coarse aggregate mix, delete the air percentage requirements and use the second bracketed sentence.
****

ACI 211.1 and ACI 301. Concrete must have a 28-day compressive strength of 28 MPa [4000] [_____] psi. [Air content of plastic concrete must be between 4 and 6 percent air by volume.] [Provide a dosage of air

entraining agent which will produce 19 plus or minus 3 percent air in a 1 to 4 by weight standard sand mortar in accordance ASTM C185.]

[2.2.2 Exposed-to-View Facing Mixture

Provide aggregates for exposed-to-view facing mixture; white, gray, or buff portland cement or a blend of two or more portland cements; [air-entraining admixture;] and water. Provide exact proportions of facing mixture to produce concrete having the specified properties and capable of obtaining the approved surface color and finish.

]2.2.3 Backing Mixture

Provide the approved mix design.

2.3 MATERIALS

2.3.1 Fine Aggregates

****
NOTE: Choose appropriate gradation based upon use of concrete. Where concrete is for back-up and separate facing aggregate is used, a gradation or maximum aggregate size may be specified.
****

ASTM C33/C33M. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. The restriction to use only fine aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply.

2.3.2 Coarse Aggregate

****
NOTE: Choose appropriate gradation based upon use of concrete. Where concrete is for back-up and separate facing aggregate is used, a gradation or maximum aggregate size may be specified. Class 5S is for exposed architectural concrete.
****

ASTM C33/C33M, Size No. [57] [67], Class 5S. The restriction to use only coarse aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply. Aggregate must not contain slag or crushed concrete.

2.3.3 Exposed Aggregate

****
NOTE: Choose appropriate gradation based upon use of concrete. Where concrete is for back-up and separate facing aggregate is used, a gradation or maximum aggregate size may be specified.
****

In addition to the above, facing mixture aggregate, and aggregate for homogeneous panels with exposed aggregate finish, will be [gravel] [crushed gravel] [crushed stone] of size and color to produce exposed surfaces to match the color and texture of the sample on file with the Contracting

Officer.

2.3.4 Cement

****

NOTE: Acceptable types of cement are:

ASTM C150/C150M Portland	[ASTM C595/C595M] Blended	Use
Type I	Type IP or IS	For general use in construction.
Type II	Type IP(MS) or Type IS(MS)	For general use in construction where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required. ASTM C595/C595M (blended hydraulic cements): add the suffix MS or MH where either moderate sulfate resistance or moderate heat of hydration, respectively, is required.

Specify either a tricalcium aluminate content of 5 percent maximum or 50 percent ground iron blast furnace slag with 50 percent portland cement or 25 percent pozzolan with 75 percent Type II portland cement when structure is within a saltwater spray range of 8 m 25 feet or within a horizontal distance of 30 m 100 feet. Require cement to meet chemical requirements of ASTMC 150/C150M, Table 1A, when using alkali-reactive aggregates.

****

ASTM C150/C150M, Type [I or II] [_____] [or ASTM C595/C595M, Type [IP(MS) or IS(MS)] [_____] blended cement except as modified herein. The blended cement must consist of a mixture of ASTM C150/C150M cement and one of the following materials: ASTM C618 pozzolan or fly ash, or ASTM C989/C989M ground iron blast furnace slag. The pozzolan or fly ash content can not exceed 25 percent, and ground slag can not exceed 50 percent, by weight of the total cementitious material.] For exposed concrete, use one manufacturer for each type of cement[, pozzolan, fly ash, and ground slag].

2.3.5 Fly Ash and Pozzolan

****

NOTE: Fly ash and slag cement may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Fly ash or pozzolan meeting the specified test results, which are more stringent than ASTM C618, should provide acceptable results, but it is recommended that fly ash, pozzolan, and ground slag not be permitted where appearance is an important factor. Fly ash or pozzolan should not be

used in panels where light colored concrete is planned without first checking with the pigment manufacturer.

****

ASTM C618, Type N, F, or C, except that the maximum allowable loss on ignition will be 6 percent for Type N and F. Add with cement.

2.3.6 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 100 or 120.

2.3.7 Admixtures

ASTM C260/C260M for air-entraining admixtures. Other admixtures: ASTM C494/C494M.[Certify that admixtures are free of chlorides.]

2.3.8 Water

Fresh, clean, and potable.

2.3.9 Reinforcement

****

NOTE: Specify ASTM A775/A775M for epoxy-coated reinforcing bars or ASTM A767/A767M and ASTM A780/A780M for zinc-coated (galvanized) bars. Define where coated bars are to be used, if not for entire project. Include ASTM publications in paragraph entitled "References":

A 767: Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

A 775: Epoxy-Coated Reinforcing Bars

A 780: Repair of Damaged Hot-Dip Galvanized Coatings

****

All exposed steel must be phosphate treated, primed, and coated to prevent rust.

2.3.9.1 Reinforcing Bars

ACI 301 unless otherwise specified. [ASTM A706/A706M, Grade [400] [60], ASTM A615/A615M, [400][60], or ASTM A966/A966M, Grade [300] [40], or ASTM A966/A966M, Grade [400] [60].]

2.3.9.2 Welded Wire Fabric

ASTM A185/A185M or ASTM A497/A497M.

2.3.9.3 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place.

a. Supports: ASTM A615/A615M, wire-type reinforcing bars and welded wire fabric.

b. Legs of supports in contact with formwork: Stainless steel, ASTM A167, Type 302 or Type 304.

2.3.10 Prestressing Strands

****
NOTE: This paragraph will be retained only when prestressed units are permitted or required.
****

Prestressing strands need to conform to ASTM A416/A416M.

2.3.11 Tie Wire

Tie wire must be soft monel or 18-8 stainless steel.

2.3.12 Inserts

Inserts will be manufacturer's standard, suited for the application.

2.3.13 Plates, Angles, Anchors and Embedment

Material will be as specified in PCI MNL-117. Coat steel items, other than stainless, with a rust-inhibiting paint or provide hot-dip galvanized steel. Steel items, including items embedded in concrete, must be either stainless steel or hot dip galvanized steel.

2.3.14 Form Release Agent

Release agent must be manufacturer's standard non-staining type.

2.3.15 Aggregates for Exposed-to-View Facing

****
NOTE: Aggregates for exposed-to-view facing mixture may be natural mineral particles, natural building stone particles, or combinations thereof, or synthetic materials such as glass or plastic; natural aggregates may be crushed or gravel.

Delete the following paragraph when crushed natural aggregate is not required by the project. Specify the mineral or rock generic name, color, particle shape, size range of particles, and other information relative to the appearance of the exposed-to-view finish surface as applicable to the project.
****

Crush coarse aggregate by a means that will produce material of cubical shape with a minimum of elongated, thin, or partially fractured particles. Material or crushing methods that produce particles classified by petrographic examination as being weak, highly fractured or somewhat friable, or both, in excess of 16 percent of the particles in any whole sample will be rejected. Material for coarse aggregate must be free of substances that change color on oxidation. Obtain material used for the work from the same basic source and stratum. Quarry material to produce a uniformly colored aggregate that does not change color upon weathering.

During quarrying operations, the uniformity of rock face color must be verified by periodically comparing the rock face color to the approved coarse aggregate sample.

****
NOTE: Revise the following paragraph when fine white-quartz aggregate is not required by the project.
****

Fine aggregate will be white quartz natural sand or stone screenings, or manufactured sand produced from white quartz. Aggregate must be free of substances that change color on oxidation. Color must conform to the approved sample.

2.3.16 Portland Cement

****
NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive Procurement Guidelines (CPG) (http://www.epa.gov/cpg/). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material. Written justification may be submitted on a Request for Waiver Form to the NASA Environmental Program Manager for approval. The Request for Waiver Form is located in the NASA Procedures and Guidelines (NPG 8830.1) (http://nodis3.gsfc.nasa.gov).
****

[Portland cement must conform to ASTM C150/C150M, Type [_____].]

[Blended hydraulic cement must conform to ASTM C595/C595M, Type [_____].]

Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.3.17 Ground Granulated Blast Furnace (GGBF) Slag

****
NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive Procurement Guidelines (CPG) (http://www.epa.gov/cpg/). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification

and supporting documentation for not procuring designated items containing recovered material. Written justification may be submitted on a Request for Waiver Form to the NASA Environmental Program Manager for approval. The Request for Waiver Form is located in the NASA Procedures and Guidelines (NPG 8830.1) (http://nodis3.gsfc.nasa.gov).

****

GGBF slag [is required] [used] as an admixture [and] must conform to ASTM C989/C989M, Grade [120] with between 25 to 50 percent maximum cement replacement by weight.

2.3.18 Air-Entrained Admixtures

Admixture must contain no sodium chloride or nitrates and will conform to ASTM C260/C260M.

2.4 Cast-In Embedded Items and Connectors

Design structural embedded anchorage and connections to panels to withstand gravity loads, live loads, dynamic loads, any volume change stresses inherent in the structure, and loads indicated.

2.4.1 Inserts

2.4.1.1 Threaded-Type Concrete Inserts

ASTM A47/A47M, Grade 22010 Grade 32510 or 35018, or may be medium strength cast steel conforming to ASTM A27/A27M, Grade 415-205 Grade U-60-30. Provide [galvanized] ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness of panel less 20 mm 3/4 inch, and internally threaded to receive 20 mm 3/4 inch diameter machine bolt. Ferrous castings must be ferritic malleable iron. [Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.]

2.4.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept 20 mm 3/4 inch diameter bolts having special wedge-shaped head. Provide ferrous castings[ASTM A47/A47M, Grade 22010, Grade 32510 or 35018, ferritic malleable iron] [or] [ASTM A27/A27M, Grade 415-205, Grade U-60-30, medium-strength cast steel]. [Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.]

2.4.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive 20 mm 3/4 inch diameter square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, must be 110 mm 4 1/2 inches minimum. Provide insert with knockout cover. Steel plate must be 3 mm 1/8 inch minimum thickness, ASTM A283/A283M, Grade C. [Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.]

2.4.1.4 Wood Nailer Inserts

****

NOTE: Location and size of wood nailer inserts must

be indicated.
****

Inserts will be kiln-dried "standard" grade Douglas fir or "No. 2" grade southern pine, surfaced 4 sides, and sized as indicated. Pressure treat wood with an approved wood preservative.

2.4.1.5 Flashing Reglets

****
NOTE: Location of flashing reglets embedded in precast-concrete panels must be indicated.
****

Reglets must be sheet metal open-type with continuous groove not less than 30 millimeter 1-1/8 inchesdeep by 5 millimeter 3/16-inch wide at opening and sloped upward, designed to anchor snap-lock counter flashing.

****
NOTE: Delete the following paragraphs if not applicable to the project.

When visible staining from the flashing reglets can occur, corrosion-resisting chromium-nickel steel only must be specified.

When the wall panels will be subjected to a sea coast atmosphere, galvanized carbon steel flashing reglets must not be specified.
****

Metal must be minimum 0.28 millimeter 0.011-inch thick conforming to ASTM A167, Type 302 or 304, No. 1 finish, soft temper.

Metal must be copper strip weighing a minimum of 4.8 kilogram per square meter 16 ounces per square foot, and conforming to ASTM B370, cold-rolled temper.

Metal is to be 0.55 millimeter 26-gage galvanized steel sheet conforming to ASTM A653/A653M, Z275 G90.

2.4.2 Embedded Plates

ASTM A36/A36M, [galvanized] ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs will use 400 MPa 60,000 psi steel with construction conforming to AWS D1.1/D1.1M, Type B. Deformed bar anchors must conform to ASTM A496/A496M. [Provide embedded anchors galvanized after fabrication in accordance with ASTM A153/A153M].

2.4.3 Embedded Attachments

2.4.3.1 Embedded Wood Nailer

Kiln-dried Standard Grade Douglas Fir or No. 2 Grade Southern Pine. Surface four sides. Treat with waterborne pressure-preservative in accordance with AWPA C1 and AWPA C2. All wood needs to be air or kiln dried after treatment. Verify specific treatments by the report of an approved independent inspection agency. The AWPA C1 and AWPA C2 Quality

Mark "C1" and "C2" on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

2.4.3.2 Flashing Reglets

****

NOTE: When visible staining from the flashing reglet can occur, chromium-nickel stainless steel should be specified. When the wall panels will be subjected to a coastal salt atmosphere, galvanized carbon steel flashing reglets should be used with care to prevent visible staining.

****

Fabricate of sheet metal, open-type with continuous groove 30 mm 1 1/8 inches deep minimum by 5 mm 3/16 inch wide at opening and sloped upward at 45 degrees. Top surface will have toothed lip section to anchor upturned edge of metal snap-lock counter flashing when inserted. [Sheet metal must be stainless steel, 0.28 mm 0.011 inch minimum thickness, ASTM A167, Type 302 or Type 304, Number 2D finish, soft temper.] [Sheet metal will be copper strip for building construction, weight 4.8 kg per square meter 16 ounce per square foot minimum, ASTM B370, cold-rolled temper.] [Sheet metal must be 0.5 mm 0.0197 inch minimum thickness (26 gage), galvanized carbon steel sheet, ASTM A653/A653M, Coating Designation Z275 G90.]

2.4.4 Connection Devices

2.4.4.1 Clip Angles

ASTM A36/A36M steel, galvanized after fabrication in accordance with ASTM A153/A153M.

2.4.4.2 Ferrous Casting Clamps

ASTM A47/A47M, Grade 22010, Grade 32510 or Grade 35018 malleable iron or cast steel, or ASTM A27/A27M, Grade 415-205 Grade U-60-30, cast steel casting, hot-dip galvanized in accordance with ASTM A153/A153M.

2.4.4.3 Threaded Fasteners

Provide galvanized machine bolts, washers and, when required, nuts.

a. Bolts: ASTM A449, 20 mm 3/4 inch diameter machine bolts with hexagon head.

b. Washers: ASME B18.21.1, medium or heavy lock-spring washers.

c. Nuts: ASTM A563M ASTM A563, Grade C, heavy, hexagon-type nuts.

d. Square Nuts: ASTM A563M ASTM A563, Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

2.4.5 Form Materials

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes within the specified fabrication tolerances.

2.5 PANEL FABRICATION

2.5.1 Formwork and Fabrication Tolerances

****
NOTE: Review PCI MNL-117 and determine whether the tolerances specified are adequate for the project.
****

Provide metal or wood forms. Brace and stiffen against deformation. Provide form liners where required to produce indicated finish. Provide dimensional tolerances as follows:

Overall panel dimensions:	
3 m	Plus 3 mm
3 to 6 m	Plus or minus 3 mm
6 m	Plus or minus 5 mm
Thickness: Plus 6 mm, minus 3 mm	
Angular deviation of sides: Plus or minus one percent, 2 mm	
Deviation from square (difference in length of two diagonals): Not to exceed 0.1 percent, 6 mm	
Size and location of openings within one unit: Plus or minus 6 mm	
Local smoothness (deviation from a true plane): Plus or minus 0.2 percent	
Bowing (convex or concave): Length of bow/480 (0.2 percent), with a maximum of 15 mm	
Position of reinforcement: Within 6 mm of indicated position	
Position of anchorage devices: Plus or minus 12 mm	
Position of pick-up devices: Plus or minus 75 mm	

Overall panel dimensions:	
10 feet or less	Plus 1/8 inch, minus zero

10 to 20 feet	Plus or minus 1/8 inch
20 feet or more	Plus of minus 3/16 inch
Thickness: Plus 1/4 inch, minus 1/8 inch	
Angular deviation of sides: Plus or minus one percent, 1/16 inch maximum	
Deviation from square (difference in length of two diagonals): Not to exceed 0.1 percent, 1/4 inch maximum	
Size and location of openings within one unit: Plus or minus 1/4 inch	
Local smoothness (deviation from a true plane): Plus or minus 0.2 percent	
Bowing (convex or concave): Length of bow/480 (0.2 percent), with a maximum of 5/8 inch	
Position of reinforcement: Within 1/4 inch of indicated position	
Position of anchorage devices: Plus or minus 1/2 inch	
Position of pick-up devices: Plus or minus 3 inches	

2.5.2 Reinforcement

ACI 301. Place reinforcing bars and welded wire fabric. Secure in position with tie wires, bar supports, and spacers.

2.5.3 Preparation for Placing Concrete

Remove hardened concrete, excess form parting compound, standing water, ice, snow, or other deleterious substances from form interiors and reinforcement before concrete placement. Secure reinforcement and embedded items.

2.5.4 Concrete Mixing and Conveying

2.5.4.1 Batch Plant, Mixer, Mixing, and Measuring of Materials

ASTM C94/C94M.

2.5.4.2 Conveying

Prevent segregation and loss of materials.

2.5.5 Concrete Placing

ACI 304R. Deposit concrete in the forms continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the precast concrete wall panel. Place concrete at a constant temperature of between 10 and 32 degrees C 50 and 90 degrees F throughout fabrication of each panel. Make temperature of forms or molds the same as or close to the concrete temperature. For hot or cold weather, use methods recommended by ACI 305R and ACI 306.1. Vibrate and consolidate concrete to prevent segregation and to produce a high-density concrete free of honeycomb and rock pockets. When specified, the exposed-to-view facing mixture is required to be a minimum thickness of 20 mm 3/4 inches. Place backing mixture before facing mixture attains initial set.

2.5.6 Identification Markings

Permanently mark each panel to indicate pick-up points, location, orientation in the building, and date of casting. Identification markings need to correlate with approved detail drawings. Do not locate in exposed-to-view finished surfaces.

2.5.7 Finishing

2.5.7.1 Unformed Concealed Surfaces (Standard Smooth Finish)

Provide a trowel finish. Level surface with a straightedge, and strike off. After surface water has disappeared, float and trowel surface. Provide smooth finished surface, free of trowel marks, and uniform in texture and appearance.

2.5.7.2 Smooth, Exposed-to-View Surfaces

Provide a standard smooth finish to all exposed-to-view surfaces of panels, unless otherwise indicated. Provide a concrete surface having the texture imparted by a steel form or other approved smooth surfaces form-facing material.

2.5.7.3 Exposed Aggregate Finish

Provide for exposed-to-view surfaces of panels, including chamfers, edges, recesses, and projections, unless otherwise indicated. Provide standard smooth finish with outer skin of mortar removed, before concrete has hardened, and exposing coarse aggregate. A chemical retarder may be used on exposed face to facilitate removal of mortar. Match finish of the approved surface finish sample. Expose aggregates as soon after concrete placing as practicable [by wire brushing, sand blasting, or bush hammering] [or] [by washing the concrete surface with a diluted solution of muriatic acid to thoroughly clean exposed aggregate. Rinse concrete surface with fresh, clean water to remove traces of acid.]

2.5.7.4 Other Surfaces

Surfaces of precast units not exposed to view or not otherwise indicated to be finished are to be finished in accordance with Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE.

2.5.8 Curing

Provide moist or steam curing or curing compound. Do not remove panel from forms; prevent moisture loss and maintain 10 degrees C 50 degrees F minimum for at least 24 hours after finishing. Maintain panels in a surface damp condition at 10 degrees C 50 degrees F minimum until concrete has attained 75 percent minimum of the design compressive strength. [Do not use steam curing with wood forms or in connection with chemically retarded exposed aggregate surfaces].

2.5.9 Repair of Surface Defects

Cut out defective areas to solid concrete, with edges of cuts perpendicular to the surface of the concrete, and clean thoroughly. Dampen area to be patched and brush-coat with nonshrink grout or bonding agent. Patch the surface in accordance with procedures previously submitted by the Contractor and approved by the Contracting Officer. Where exposed to view, the patches, when dry, needs to be indistinguishable from the surrounding surfaces.

2.5.9.1 Smooth, Concealed Surfaces

Acceptable defective area will be limited to holes left by rods and other temporary inserts, and to honeycomb or rock pockets of 6 mm 1/4 inch diameter maximum. Remove fins and other projections on the surfaces.

2.5.9.2 Exposed-to-View Surfaces

The combined area of acceptable defective areas must not exceed 0.2 percent of the exposed-to-view surface area and will be limited to holes of 6 mm 1/4 inch diameter maximum.

2.5.10 Embedded Accessories

Furnish and install anchors, inserts, lifting devices, and other accessories which are to be embedded in the precast units in accordance with the approved detail drawings. Embedded items must be accurately positioned in their designed location, and have sufficient anchorage and embedment to satisfy design requirements.

2.5.11 Stripping

Do not remove precast concrete units from forms until units develop sufficient strength to safely strip the formwork and to remove the precast concrete units from the forms to prevent damage to the units from overstress or chipping.

2.5.12 Forms

****
NOTE: Precast concrete wall panel dimensions, cross sections, and details of edges, sills, soffits, and reveals, as required by the project, must be indicated.
****

Forms and facing materials must be wood, metal, plastic, or other approved material that is non-reactive with concrete. Completed panels must conform to the shapes, lines, and dimensions indicated, within the limits of the

specified fabrication tolerances.

2.5.13 Built-In Anchorage Devices

****
NOTE: Anchorage devices to be embedded in the panels must be indicated. Anchorage devices include threaded concrete inserts for bolted connections; wood nailers to receive thermal insulation that will be applied to the panel; and flashing reglets to receive sheetmetal counter flashing.
****

Accurately position and securely anchor all anchorage devices. Openings in anchorage devices must be filled temporarily to prevent entry of concrete.

2.5.14 Lifting Devices

Lifting devices must be provided, and designed for a safety factor of 4, which includes 100 percent impact. Do not use brittle material.

2.5.15 Weather Limitations

Do not place concrete when the temperature of the atmosphere is below 5 degrees C 40 degrees Fnor during rain, sleet, or snow unless adequate protection is provided. Protection during inclement weather must prevent entry of rain, sleet, or snow into the forms or into the fresh concrete.

2.5.16 Finishing for Formed Surfaces

Prior to panel fabrication, three samples of Exposed-to-View Surface Finish (300 by 300 millimeter) (12 by 12 inches), and Finish Aggregate for exposed-to-view facing material is to be provided by the Contractor.

After approval of the surface, Contractor must provide one full size sample Wall Panel. Approved sample may be used in construction when properly identified.

Upon removal of forms, repair and patch defective areas. Where the finished surface will be exposed to view, the combined area of defective areas must not exceed 0.2 percent of the surface and will be limited to honeycomb or rock pockets not deep enough to expose the reinforcement. Where the finished surface will be concealed by other construction, defective areas are limited to holes left by the rods and other temporary inserts and honeycomb or rock pockets not deep enough to expose the reinforcement. Defective areas must be cut out to solid concrete, cleaned, and patched with grout. Where concrete surface will be exposed to view, the patches, when dry, must be indistinguishable from the surrounding surfaces.

****
NOTE: Delete the following paragraph, and specify the required finish or finishes when an exposed-aggregate finish is not required for exposed-to-view panel surfaces. Other finishes include textured form finishes, sculptured inserts, rubbed finishes, and combinations thereof; such finishes may require the specified exposed-to-view facing mixture.

It is recommended that a sample of the required exposed-to-view finish be on display where it may be seen by bidders during the bidding period.

****

Exposed-aggregate finish must match the finish of the approved sample. Aggregates in exposed-to-view surfaces will be exposed as soon after concrete placing as practical by power sanders, wire brushes, or other acceptable methods. Give surfaces one or more washings with a dilute solution of muriatic acid, then washed with fresh, clean water to remove all traces of the acid.

2.6 JOINT MATERIALS

****

NOTE: Cross sections of gaskets with dimensions must be indicated.

****

Gasket must be elastomeric material, premolded to cross section indicated.

Material must be a vulcanized closed-cell expanded chloroprene conforming to ASTM D1056, Grade No. SCE 42, with the following additional properties:

Brittleness temperature will be minus 5 degrees C 40 degrees F when tested in accordance with ASTM D746.

Flammability resistance needs to be self-extinguishing when tested in accordance with ASTM D635.

Resistance to ozone must be "no cracks" after exposure of a sample, at 20 percent elongation, to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 40 degrees C 104 degrees F when tested in accordance with ASTM D1149.

2.7 MISCELLANEOUS ARCHITECTURAL PRECAST CONCRETE SYSTEMS

2.7.1 Thin Brick Veneer

As the precast requirements for thin brick tolerances are stricter than what is acceptable in laid-up masonry, more care is often taken in the manufacturing process to produce a quality thin brick.

ASTM International has issued a standard specification for "Thin Brick Veneer Units Made from Clay or Shale." This specification, identified as Designation: ASTM C1088, addresses such product dynamics as absorption, warpage, freeze/thaw, weight loss, durability, and size dimensions.

As with face brick, thin brick shades can vary substantially within any color selection. Because it is a baked, or kilned, product these variations of color are inevitable and have been part of the nature of brick for centuries.

Thin brick sample boards offer a general example of available colors and finishes.

A mock up panel of at least sixteen square feet is also recommended. Often, these mock up panels must be produced prior to manufacture of the

brick, so it must be understood that they are only a 'close' representation of the actual product. It is also important to use the same method of cleaning and sealing of the brick that will be used in production. Waxes, acids, and sealers may have a slight impact on color and shade.

2.7.1.1 Storage of Thin Brick

Thin brick is generally packed in cartons, palletized, and wrapped in protective plastic for transportation. The brick itself is relatively impervious to the elements. However the protective coatings that are often applied to the face of the brick may weather or age.

It is advisable to protect the brick from extreme heat until it is installed and cast. In addition, excessive dust and dirt may affect the brick's ability to bond to the concrete properly. Care should be taken to keep the brick covered and protected from the sun prior to its installation.

2.7.1.2 Engineering Considerations

1. Pullout tests

2. Pre-stress or post tensioning, (deflection criteria)

3. Freeze thaw tests

4. Module openings, corners & quirk joints

2.7.1.3 Placing Concrete

1. Concrete Placement

When placing concrete, take care not to create currents with the concrete that could disturb the brick. Placement should be done in such a way that there is little or no forceful impact of concrete onto the brick.

2. Self consolidating concrete

Self consolidating, sometimes called 'self compacting' or 'self leveling' concrete, is considered the easiest to place. It requires little to no vibration, and rarely disturbs the brick.

3. Vibration

Consolidating the concrete through vibration rarely causes brick to become dislodged from the liner. Brick will not 'float' into the concrete under normal conditions.

Do not lay the vibrator horizontal and drag it into, or along the surface of, the concrete. When the vibrator is properly inserted the energy affects a broader area and does not induce strong concentrated currents that may tilt brick.

4. Re-bar chairs

Adhere to rule of thumb of minimum of 1.5 times the diameter of the re-bar from the surface to the steel (surface is back of brick).

5. Slump of concrete

It is not necessary to adjust the slump from the normal setting in order to accommodate the thin brick.

2.7.2 Glass Fiber Reinforced Concrete Panels (GFRC)

Glass fiber reinforced concrete (GFRC) is the term applied to products manufactured using a cement/aggregate slurry reinforced throughout with alkali resistant glass fibers.

GFRC does not consist of a single composition, but can be manufactured using different combinations of materials to meet the required properties. Mix composition, degree of compaction, type of cement, and the proportion, length, and orientation of glass fibers may all be varied to produce a specific product. Typically, a GFRC panel consists of 5 percent by weight (of total mix) of alkali resistant glass fiber (absolute minimum of 4 percent) combined with a portland cement/sand slurry. Methods of manufacture vary, but spraying either by hand equipment onto a form of the desired shape and size, or mechanically on a production line are most common.

It is important to understand that the material is a composite with reinforcing elements randomly distributed throughout the matrix, unlike reinforced concrete where the reinforcing steel is placed primarily in tensile stress areas.

Currently, GFRC is not considered as a vertical load-bearing component or as part of the lateral load-resisting system, although it can accept and transfer wind and self-weight and its own inertial seismic loads to the building's load resisting system. GFRC panels are used primarily as cladding or fascia panels.

GFRC systems can be designed to provide a 2-hour fire resistance rating using fire rated insulation and drywall. In addition, GFRC does not contribute to the fire load of the building.

2.7.2.1 Responsibilities

The PCI Code of Standard Practice for Precast Concrete is a compilation of practices and recommendation for design, manufacture and erection of precast concrete that also provides an excellent guide for GFRC panel fabrication and erection.

Areas of contractual responsibility that should be clearly assigned in the contract documents are:

1. Panel design
2. Installing, furnishing, and design of connection hardware
    a. Attached to the building frame
    b. Furnished loose
    c. Secured to the panel
    d. Integral with the panel
3. Panel installation
4. Sealing or coating
5. Joint sealant
6. Panel cleaning

Design calculations should be performed under the supervision of a

registered professional engineer with experience in GFRC design. The GFRC manufacturer should be prepared to assist in the design of panels and connections. The owner's [Architect][Engineer] maintains ultimate design responsibility.

Contract drawings prepared by the [Architect][Engineer] should show connections in sufficient detail to permit design, estimating, and bidding. Panel manufacturers, during the preparation of shop drawings, usually review connections for tolerances, clearances, practicality, and performance. The manufacturer should call to the [Architect's][Engineer's] attention any recognized conflicting conditions.

PART 3 EXECUTION

3.1 GENERAL

Install panels and accessories in accordance with the approved shop drawings and as specified.

If substrate preparation is the responsibility of an installer other than the Contractor, notify Architect of unsatisfactory preparation before proceeding.

3.2 EXAMINATION

Do not begin installation until supporting structures have been properly prepared.

If support structure is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

Verify that all parts of the supporting structure are complete and ready to receive the panels and that site conditions are conducive to proper installation. Install precast concrete wall panels and accessories in accordance with approve detail drawings and descriptive data, and as specified below.

3.3.1 Building Framing System

Provide supporting members, including anchorage items attached to or embedded in building structural elements, prior to placement of panels.

3.3.2 Placing Panels

Panels must attain the specified 28-day compressive design strength prior to placement. Provide temporary supports and bracing, as required, to maintain panel position and alignment during attachment to the building framing system. Secure adjustable connections after panels have been properly positioned. All welded connections need to conform to the requirements of AWS D1.1/D1.1M and AWS D1.4/D1.4M.

3.3.3 Erection Tolerances

****
NOTE: Review PCI MNL-117 and determine whether the tolerances specified are adequate for the project.
****

Locate panels to accommodate adjacent products, proper joint width, and alignment with adjacent precast members. Non-cumulative dimensional tolerances for erection of panels are as follows:

a. Face width of joint

Panel dimension normal to joint

3 m 10 feet or under: Plus or minus 5 mm 3/16 in

3 m to 6 m 10 feet to 20 feet: Plus 5 mm minus 6 mm 3/16 inch minus 1/4 inch

Each additional 3 m 10 feet: Plus or minus 2 mm 1/16 inch

b. Joint taper (panel edges not parallel): 0.2 percent or 2 mm 1/16 inch total, whichever is larger, but not greater than 10 mm 3/8 inch

c. Panel alignment

Jog in alignment of edge: 6 mm 1/4 inch

Offset in face of panel (exterior face unless otherwise noted): 6 mm 1/4 inch

d. Variation from theoretical position, any location: Plus or minus 6 mm 1/4 inch

e. Deviation from plumb: 0.2 percent, 10 mm 3/8 inch maximum

f. Maximum warpage after erection: One corner out of plane of other three, 0.5 percent of distance from nearer adjacent corner, or 3 mm 1/8 inch

g. Differential bowing or camber of adjacent panels: 6 mm 1/4 inch maximum

3.3.4 Joints

Joint widths between panels will be as specified unless otherwise indicated. Provide joints with sealants in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.4.1 JOINT SEALING

Joint sealing will be as specified in Section 07 92 00 JOINT SEALANTS.

3.3.5 Protection

Protect exposed-to-view facing from staining and other damage. Do not allow laitance to penetrate, stain, or harden on exposed surfaces.

3.4 ERECTION

Erect precast units in accordance with the detail drawings and without damage to other units or to adjacent members. Set units true to alignment and level, with joints properly spaced and aligned both vertically and

horizontally. Erection tolerances must be in accordance with the requirements of PCI MNL-117 and PCI MNL-122. As units are being erected, shims and wedges will be placed as required to maintain correct alignment. After final attachment, grout precast units as shown. After erection, clean and touch-up welds and abraded surfaces of steel with a zinc-rich paint. Welds must be made by a certified welder in accordance with the manufacturer's erection drawings. Finish pickup points, boxouts, inserts, and similar items to match adjacent areas after erection. Erection of precast units must be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders must be in accordance with AWS D1.1/D1.1M.

3.5 PROTECTION OF WORK

Protect precast units against damage from subsequent operations.

3.6 DEFECTIVE WORK

Repair precast concrete units damaged during erection as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units must match the adjacent surfaces in color and texture, as approved. Unless otherwise approved, repair procedures will conform to [PCI MNL-116] [and] [PCI MNL-117].

3.7 CONCRETE INSERTS EMBEDDED IN CAST-IN-PLACE CONCRETE

****
NOTE: Delete paragraph heading and the following paragraph when the precast concrete wall panels will not be attached to cast-in-place concrete structural members. Installation of concrete inserts embedded in cast-in-place concrete is specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.
****

Deliver inserts to the site in time to be installed before the start of concrete placing. Contractor must provide setting drawings, instructions, and directions for the installation of inserts.

3.8 CONCRETE STRENGTH AT TIME OF PANEL INSTALLATION

****
NOTE: Delete one of the following paragraphs as applicable to the project. First paragraph will be selected except when the project schedule indicates installation of 28-day panels.
****

Do not install panels until concrete has attained the minimum laboratory compressive strength at 28 calendar days specified.

Do not install panels before 28 calendar days from the date of casting unless approval has been obtained to make one compressive strength test, ASTM C39/C39M, and one flexural strength test using simple beam with third-point loading, ASTM C78/C78M, on field cured concrete test specimens, ASTM C31/C31M, for each individual panel to determine the strength of the concrete.

3.9 INSTALLATION TOLERANCES

Install panels within the tolerances specified in PCI MNL-116.

3.10 PLACING PANELS

Supporting members, including anchorage items attached to or embedded in building structural elements, must be in place before placing panels is started.

Install panels plumb, level, in alignment, and within limits of the installation tolerances.

3.11 CONNECTIONS TO THE BUILDING FRAMING SYSTEM

Connect panels to the building framing system as indicated on the approved shop drawings. Fix adjustable connections by locknuts or other approved means after panels have been positioned.

3.12 JOINTS AND GASKETS

Joints between panels must be the width indicated and within limits of installation tolerances.

Install gaskets in joints as indicated, continuous throughout the joint length, and compressed at least 25 percent by volume.

3.13 PROTECTION

Protect panels against staining of exposed-to-view facing and other damage until completion of the work.

3.14 INSPECTION AND ACCEPTANCE PROVISIONS

****

NOTE: When prestressed precast concrete wall panels are required, refer to Section 03 41 33 PRECAST STRUCTURAL PRETENSIONED CONCRETE.

****

3.14.1 Evaluation of Compressive Strength Tests

Concrete quality control tests specified will be evaluated as specified.

Concrete delivered to the point of placement having a slump or total air content outside the values specified must not be used in the work.

Compressive strength tests will be considered satisfactory if the average of any group of five consecutive compressive strength tests which may be selected is in each instance equal to or greater than the 28-day design compressive strength, or if not more than one compressive strength test in 10 has a value less than 90 percent of the 28-day design compressive strength.

If the compressive strength tests fail to meet the minimum requirements specified, panels fabricated of concrete represented by such tests will be considered deficient in strength and subject to the provisions specified.

3.14.2 Dimensional Tolerances

Panels having dimensions outside the limits for fabrication tolerances will be rejected.

3.14.3 Surface Finish Requirements

Panels will be rejected for the following surface finish deficiencies:

Exposed-to-view surfaces that do not match the color, aggregate size and distribution, and texture of the approved sample

Exposed-to-view surfaces that contain defects that affect the appearance of the finish, such as cracks, spalls, honeycomb, rock pockets, or stains and discoloration of aggregate or matrix that cannot be removed by cleaning

Concealed surfaces that contain cracks in excess of 0.2 millimeter 0.01 inch wide, cracks that penetrate to the reinforcement regardless of width, honeycomb, rock pockets, and spalls except minor breakage at corners and edges

3.14.4 Strength of Panels

Strength of precast concrete panels will be considered potentially deficient if the panels fail to comply with the requirements that control the strength of the panels, including the following conditions:

Failure to meet compressive strength tests

Reinforcement not conforming to the requirements specified

Concrete curing and protection of panels against extremes of temperature during curing not conforming to the requirements specified

Panels damaged during handling and erection

3.14.5 Testing Panels for Strength

When there is evidence that the strength of precast concrete panels does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination must be made in accordance with ASTM C42/C42M and as follows:

Take at least three representative cores from the precast-concrete panels that are considered potentially deficient.

Test cores with the saturated surface dry.

Strength of cores will be considered satisfactory if their average is equal to or greater than 90 percent of the 28-day design compressive strength of 150 by 300 millimeter 6 by 12 inch cylinders.

Submit test reports on the same day that tests are made. Reports must contain the project name and number, date, name of contractor, name of precast concrete wall panel manufacturer, name of concrete-testing service, identification letter and number of panel or panels represented by core tests, nominal maximum size of aggregate, design compressive strength of concrete at 28 calendar days, compressive breaking strength and type of

break, length of core test specimen before capping, compressive strength after correcting for length diameter ratio, direction of application of the load on the core test specimen with respect to the horizontal plane of the concrete as placed, and the moisture condition of the core test specimen at time of testing.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, make static load tests of a panel and will be evaluated in accordance with ACI 305.1 and ACI 318M ACI 318.

Replace panels used for core tests or static load tests with panels that meet the requirements of this section.

3.14.6 Panels-in-Place

Panels will be rejected for any one of the following deficiencies:

Panels not conforming to the requirements for installation tolerances

Panels that are damaged during construction operations

Panels that develop surface-finish deficiencies as specified

3.15 CLEANING

Clean exposed-to-view surfaces of panels thoroughly with detergent and water; use a brush to remove foreign matter. Remove stains that remain after washing in accordance with recommendations of the panel manufacturer. Surfaces must be clean and uniform in color.

3.16 SAMPLING AND TESTING

3.16.1 Product Quality Control

PCI MNL-117 for PCI enrolled plants. Where panels are manufactured by specialists in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-117 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

3.16.1.1 Aggregate Tests

ASTM C33/C33M. Perform one test for each aggregate size, including determination of the specific gravity.

3.16.1.2 Strength Tests

ASTM C172/C172M. Provide ASTM C39/C39M and ASTM C31/C31M compression tests. Perform ASTM C143/C143M slump tests. Mold six cylinders each day or for every 15 cubic meters 20 cubic yards of concrete placed, whichever is greater. Perform strength tests using two cylinders at 7 days and two at 28 days. Cure four cylinders in the same manner as the panels and place at the point where the poorest curing conditions are offered. Moist cure two cylinders and test at 28 days.

3.16.1.3 Changes in Proportions

If, the compressive strength falls below that specified, adjust the mix

proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

3.16.1.4 Strength Test Results

Evaluate compression test results at 28 days in accordance with ACI 214R using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests can have an average compressive strength less than the specified ultimate compressive strength.

3.16.2 Rejection

Panels in place may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 6 m 20 feet in broad daylight.

a. Nonconformance to specified tolerances.

b. Air voids (bugholes or blowholes) larger than 10 mm 3/8 inch diameter.

c. Visible casting lines.

d. Visible from joints.

e. Visible irregularities.

f. Visible stains on panel surfaces.

g. Visible differences between panel and approved sample.

h. Visible non-uniformity of textures or color.

i. Visible areas of backup concrete bleeding through the facing concrete.

j. Visible foreign material embedded in the face.

k. Visible repairs.

l. Visible reinforcement shadow lines.

m. Visible cracks.

3.16.3 Field Quality Control

Perform field inspection of panel connections. Notify the Contracting Officer in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections or welds are to be removed and re-welded or repaired as required by the Contracting Officer.

3.16.3.1 Welded Connection Visual Inspection

AWS D1.1/D1.1M, furnish the services of AWS-certified welding inspector for

erection inspections. Welding inspector must visually inspect all welds and identify all defective welds.

-- End of Section --