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USACE / NAVFAC / AFCESA / NASA **UFGS-30 45 33 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change UFGS-03410 (December 2004)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 19 March 2007
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DIVISION 03 - CONCRETE

SECTION 30 45 33

PRECAST[PRESTRESSED] STRUCTURAL CONCRETE

04/06

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SECTION 30 45 33

PRECAST[PRESTRESSED] STRUCTURAL CONCRETE
04/06

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NOTE: This guide specification covers the requirements for precast non-prestressed and precast prestressed concrete used for structural purposes (planks, columns, etc.) and for minor architectural purposes (copings, window sills, etc.) in building and waterfront facilities construction.

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 and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of the technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).
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NOTE: This guide specification does not cover precast concrete wall panels (Section 03 45 00 PLANT-PRECAST ARCHITECTURAL CONCRETE), major precast non-prestressed architectural concrete, post tensioned concrete, or precast concrete which is site manufactured and shall not be used for bridge or roadway construction. Precast concrete sound fences should be considered in lieu of block walls for use where sound barriers are used for noise abatement.
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NOTE: The following information shall be shown on the project drawings:

1. Live and dead loads, and whether the topping is included in the dead load.

2. Details of fitting, bearing, and connections.

3. Location of expansion and control joints.

4. Style and area of steel fabric reinforcement in areas where required. Kind and size of reinforcing bars and spacing.

5. Strength and type of concrete.

6. Detail of placement of sealant or fillers in joints.

7. Fire rating.

8. Lightweight concrete unit weight.

9. Special requirements for concrete cover over reinforcing.

10. Areas where toppings are required, indicate areas where the full thickness of the topping is not present.

11. Camber.

12. Tendon types, physical properties, and allowable design stresses.

****

PART 1 GENERAL

1.1 REFERENCES

****

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.

****

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

ACI INTERNATIONAL (ACI)

ACI 304R	(2000) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(1999; Errata 2006) Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 309R	(2005) Guide for Consolidation of Concrete
ACI 318/318R	(2005) Building Code Requirements for Structural Concrete and Commentary
ACI 318M	(2005) Metric Building Code Requirements for Structural Concrete and Commentary

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges
AASHTO T 259	(2002) Resistance of Concrete to Chloride Ion Penetration

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(2004) Basic Hardboard

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2005; E 2005) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 185/A 185M	(2006; E 2006) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 27/A 27M	(2005) Standard Specification for Steel Castings, Carbon, for General Application

ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(2006) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(2005) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 Mpa Minimum Tensile Strength (Metric)
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 416/A 416M	(2006) Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A 421/A 421M	(2005) Standard Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete
ASTM A 47/A 47M	(2004) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 496/A 496M	(2005) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497/A 497M	(2006; R 2006) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 563	(2004a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 563M	(2006) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A 615/A 615M	(2006a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706/A 706M	(2006a) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 722/A 722M	(2006) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A 767/A 767M	(2005) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A 775/A 775M	(2006) Standard Specification for Epoxy-Coated Steel Reinforcing Bars

ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 82/A 82M	(2005a) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 934/A 934M	(2004) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A 996/A 996M	(2006a) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars or Concrete Reinforcement
ASTM C 1069	(1986; R 2004e1) Standard Test Method for Specific Surface Area of Alumina or Quartz by Nitrogen Adsorption
ASTM C 1107/C 1107M	(2007) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1202	(2005) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C 1218/C 1218M	(1999) Standard Specification for Water-Soluble Chloride in Mortar and Concrete
ASTM C 1240	(2005) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 1260	(2005a) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 311	(2005) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 330	(2005) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C 430	(2003; R 2003) Fineness of Hydraulic

	Cement by the 45-Micrometer (No. 325) Sieve
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 595	(2006) Standard Specification for Blended Hydraulic Cements
ASTM C 618	(2005) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM F 436	(2004) Hardened Steel Washers
ASTM F 436M	(2004) Hardened Steel Washers (Metric)
ASTM F 844	(2004) Washers, Steel, Plain (Flat), Unhardened for General Use

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
PCI MNL-120	(2004) Design Handbook - Precast and Prestressed Concrete
PCI MNL-124	(1989) Design for Fire Resistance of Precast Prestressed Concrete

UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(2007) Fire Resistance Directory Set

1.2 SYSTEM DESCRIPTION

The work includes the provision of precast [non-prestressed concrete herein referred to as precast members][and][precast, prestressed concrete herein referred to as prestressed members] [except that precast concrete wall panels shall be provided as specified in Section 03 45 00, "Plant-Precast Architectural Concrete"]. [Precast] [and][Prestressed] members shall be the product of a manufacturer specializing in the production of precast [prestressed] concrete members.

****

NOTE: When concrete toppings are indicated, they are normally allowed to be used in establishing the design strength of the precast [prestressed] member. However, areas where the topping is not the full

thickness, and areas without topping located inside of larger areas with topping need to be indicated so that the topping is not used in the untopped areas to establish the design strength of the precast [prestressed] members.

****

1.2.1 Design Requirements

Design precast [prestressed]members in accordance with ACI 318MACI 318/318R and the PCI MNL-120. Design precast [prestressed] members (including connections) for the design load conditions and spans indicated, and handling and erection stresses, and for additional loads imposed by openings and supports of the work of other trades. Design precast[prestressed] members for handling without cracking in accordance with the PCI MNL-120. [Concrete toppings shall [not] be used in establishing the design strength of the precast[prestressed] members.]

****

NOTE: Evaluate the loading requirements for the member design including all dead and live loads, and other specified loads for member, where applicable. Show design loads on the drawings. The designer of the precast [prestressed] members should also consider the effects of initial handling and erection stress in the final design of the elements.

****

1.2.1.1 Loads

Loadings for members and connections shall include all dead load, live load, applicable lateral loads such as wind and earthquake, applicable construction loads such as handling, erection loads, and other applicable loads.

1.2.1.2 Drawing and Design Calculation Information

****

NOTE: Modify requirements based on the scope of the project.

****

Submit drawings and design calculations indicating complete information for the fabrication, handling, and erection of the precast[prestressed] member. Drawings shall not be reproductions of contract drawings. Design calculations[, drawings of precast members][[, and]drawings of precast prestressed concrete members] (including connections) shall be made by a registered professional engineer experienced in the design of precast [prestressed]concrete members[and register in the state where the project is located], and submitted for approval prior to fabrication. The drawings shall indicate, as a minimum, the following information:

a. Plans, elevations and other drawing views showing the following:

(1) Member piece marks locating and defining products furnished by the manufacturer.

(2) Headers for openings.

(3) Location and size of openings [that cut prestressing strands or require the location of prestressing strands to miss field cut openings].

(4) Relationships to adjacent material.

(5) Joints and openings between members and between members and other construction.

(6) Location of field installed anchors.

(7) Erection sequences and handling requirements

[(8) Areas receiving toppings and magnitude of topping thickness. Identify areas where topping is an integral part of the structural capacity of the precast members.]

(9) Lifting and erection inserts

b. Elevations, sections and other details for each member showing the following:

(1) Connections between members and connections between members and other construction.

(2) Connections for work of other trades and cast-in items and their relation to other trades.

(3) Dimensioned size and shape for each member with quantities, position and other details of reinforcing steel, anchors, inserts and other embedded items.

(4) Lifting, erection and other handling devices and inserts.

(5) Surface finishes of each member.

(6) Estimated cambers

[c. Magnitude, schedule and sequence of tensioning and detensioning prestressing strands.]

d. Strength properties for concrete, steel and other materials.

e. Methods for storage and transportation.

f. Description of loose, cast-in and field hardware.

g. All dead, live, handling, erection and other applicable loads used in the design.

1.2.2 Performance Requirements

****

NOTE: Edit when precast [prestressed] members are to be fire rated. On most large jobs, not all members will have the same fire rating, so fire ratings for each specific member should be indicated for clarity.

****

[Precast[prestressed] members [where indicated] shall have a fire rating [of [_____]-hours] [as indicated] in accordance with UL Fire Resist Dir, or as designed in accordance with PCI MNL-124.]

1.3 MODIFICATION TO REFERENCE

In the ACI publications, the advisory provisions shall be considered to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears; reference to the "Building Official," the "Structural Engineer" and the "Architect/Engineer" shall be interpreted to mean the Contracting Officer.

1.4 SUBMITTALS

****

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. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings of precast members[; G][; G, [_____]]

Drawings of precast prestressed concrete members[; G][; G, [_____]]

SD-03 Product Data

Anchorage and lifting inserts and devices

Bearing pads

SD-04 Samples

****
NOTE: Sample panels should only be required when a finish Grade A or better is specified.
****

Surface finish

Submit two 300 by 300 by 50 mm 12 by 12 by 2 inch thick sample panels representative of the color and finish for each type of precast member requiring a finish Grade [A] [_____] surface finish.

SD-05 Design Data

[Precast][Prestressed] concrete members design calculations; G, [_____]

Concrete mix design[; G][; G, [_____]]

SD-06 Test Reports

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

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other test for cement, [silica fume,]aggregates, and admixtures. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained versus sieve size. Test reports shall be submitted along with the concrete mix design. Obtain approval before concrete placement.

Cement

Pozzolan

[Air-Entraining Admixture]

[Water-Reducing Admixture]

[Accelerating Admixture]

****
NOTE: Require aggregate quality testing on large concrete projects, where concrete is exposed to seawater, alkali soils, moist conditions, or the quality of aggregates is questionable.

****

[Aggregates]

[Submit test results for aggregates in accordance with ASTM C 1260 for potential alkali-silica reactions.]

SD-07 Certificates

Quality control procedures

Submit quality control procedures established in accordance with PCI MNL-116 by the precast manufacturer.

[Construction Records[; G][; G, [_____]]]

[Construction records of the manufacturing, handling, and erection of the precast prestressed concrete members shall be submitted.]

[Epoxy-coated steel bars]

[Written certification for coating material and coated bars shall be submitted with the delivery of the bars.]

SD-11 Closeout Submittals

Concrete batch ticket information

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Manufacturer Qualifications

****

NOTE: Use first bracketed paragraph unless no PCI certified plant are available. Then select the second paragraph.

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 Deflected Strand Structural Members.

****

[PCI MNL-116. Plants shall be certified by the PCI Plant Certification Program for Category [C1] [C2] [C3] [C4] work. At the Contracting Officer's option, PCI Plant quality control program records shall be available for review.]

[PCI MNL-116. 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-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.]

1.5.1.2 Designer Qualifications

The designer shall be a registered professional engineer[in the state where the project is located] experienced in the design of precast [prestressed] concrete.

1.5.1.3 Erector Qualifications

****
NOTE: Coordinate requirements for experience with Contracting Officer.
****

The erector shall be regularly engaged for at least [three] [_____] years in the erection of precast [prestressed] structural concrete similar to the requirements of this project.

1.5.1.4 Welding Qualifications

Provide AWS D1.1/D1.1M qualified welders who are currently certified at contract award date and have maintained their certificates over the past year.

1.5.2 Regulatory Requirements

****
NOTE: Modify to add any local codes and regulations.
****

Provide precast [prestressed] members in conformance with ACI 318M ACI 318/318R and AWS D1.4/D1.4M.

1.5.3 Concrete Mix Design

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, [silica fume,]ground slag, and admixtures, and applicable reference specification. Provide mix proportion data using at least three different water-cement ratios for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. No material shall be provided unless proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. The submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregates changes.

1.5.4 Certificates: Record Requirement

ASTM C 94/C 94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Transportation

1.6.1.1 Transporting Members

In transporting members by truck, railroad car, or barge, provision shall be made for supporting the members as described above, except battens can be continuous over more than one stack of units, with adequate bracing to ensure their maintaining the vertical position and damping of dangerous vibrations. Trucks with double bolsters are satisfactory provided the members are fully seated on the outer bolsters at not more than 1 m 3 feet or the depth of the member from the end and the inner bolster is not more than 2.3 m 8 feet from the end of the member or the designated pickup point. Adequate padding material shall be provided between tie chains or cables to preclude chipping of concrete.

1.6.1.2 Lateral Deflection or Vibration

Any noticeable indication of lateral deflection or vibration during transportation shall be corrected by rigid bracing between members or by means of lateral trussing.

1.6.2 Storage

1.6.2.1 Storage Areas

Storage areas for precast [prestressed] members shall be stabilized, and suitable foundations shall be provided, so differential settlement or twisting of members will not occur.

1.6.2.2 Stacked members

Stacked members shall be separated and supported by battens placed across the full width of each bearing point. Battens shall be arranged in vertical planes at a distance not greater than the depth of the member from designated pickup points. Battens shall not be continuous over more than one stack of precast units. Stacking of members shall be such that lifting devices will be accessible and undamaged. The upper members of a stacked tier shall not be used as storage areas for shorter members or equipment.

1.6.3 Handling of Members

The location of pickup points for handling of the members and details of the pickup devices shall be shown in shop drawings. Members shall be handled only by means of approved devices at designated locations. Members shall be maintained in an upright position at all times and picked up and supported as shown in approved shop drawings.

PART 2 PRODUCTS

2.1 CONTRACTOR-FURNISHED MIX DESIGN

****

NOTE: Normal precast design is based on concrete having a compressive strength of 35 MPa 5000 psi at 28 days. Some precast manufacturers like to speed up production by using Type III (high early strength) concrete. For marine exposure, (or

moderate and severe sulfate exposure) include last bracketed sentence, which limits the water-cement ratio to a maximum of 0.40.

****

****

NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.

****

ACI 318MACI 318/318R. The minimum compressive strength of concrete at [28] [_____] days shall be [35 MPa] [5000 psi] [_____], unless otherwise indicated. [Add air-entraining admixtures at the mixer to produce between 4 and 6 percent air by volume.][For marine exposure, ensure a dense concrete free of shrinkage cracks, with a minimum degree of permeability. The maximum water cement ratio shall be 0.40 .]

2.2 MATERIALS

2.2.1 Cement

****

NOTE: Insert type of cement required. Generally, Types I and II and Type III, with 8 percent maximum tricalcium aluminate (C3A) are used. In very special cases, Type V, "low alkali," which has limited availability, may be used.

****

****

NOTE: Cement type and quantity of cement required in mix design is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling:

(a) CHLORIDE PROTECTION:

Normal Use. In fresh water or air environment, specify Type I or Type II cement. Type III may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent.

Marine Use. In soil or water environments, subject to chlorides above 1,000 ppm, specify Type II cement and minimum 7.85 sacks of cement per cubic meter six sacks cement per cubic yard.

Seawater Exposure. In direct contact with ocean water, specify Type II and a minimum of 9.15 sacks of cement per cubic meter seven sacks of cement per cubic yard.

(b) SULFATE RESISTANCE

Normal Use. In soils with negligible amount of sulfate, specify Type I, II, or III (tricalcium aluminate (C3A) content, max. 8 percent) cement. When in doubt, specify Type II cement and a minimum of 7.85 sacks of cement per cubic meter six sacks of

cement per cubic yard.

Moderate Sulfate Exposure. In exposures with moderate sulfate content (between 0.10 and 0.20 percent in soil and less than 1500 ppm in water), specify Type II or III (tricalcium aluminate (C3A) content, max. 8 percent) and a minimum of 7.85 sacks of cement per cubic meter six sacks of cement per cubic yard. Do not use Class C fly ash.

Severe Sulfate Exposure. In exposures with high sulfate content (exceeds 0.20 percent in soil or 1500 ppm in water), specify Type III or V with a maximum tricalcium aluminate content of 5 percent and a minimum of 9.15 sacks of cement per cubic meter seven sacks of cement per cubic yard. Do not use Class C fly ash.

****

ASTM C 150, [Type I, II, or III[ ] with a maximum alkali content of 0.40 percent][; or] [ASTM C 595 Type [IP(MS) or IS(MS)][ ] blended cement, except as modified herein. The blended cement shall consist of a mixture of ASTM C 150 cement (with alkali content exceeding 0.40 percent) and one of the following materials: ASTM C 618 pozzolan or fly ash, or ASTM C 989 ground iron blast furnace slag. The pozzolan/fly ash content shall not be less than 25 percent nor exceed 40 percent by weight of the total cementitious material. The ground iron blast-furnace slag shall not exceed 50 percent by weight of total cementitious material.] If no satisfactory test results are available (made within the past six months) to prove that the cement alkali content is less than 0.40 percent, then it shall be assumed that the cement contains greater than 0.40 percent alkali. Cement certificates shall include test results in accordance with ASTM C 150, including equivalent alkalies indicated in the optional chemical requirements. [Use cement with a tricalcium aluminate (C3A) content of less than [8][5] percent.] For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.2.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum calcium oxide content shall be 8.0 percent, the maximum available alkalies shall be 1.5 percent, and the maximum allowable loss on ignition shall be 6 percent for Type N and F. Class C shall not be used with reactive aggregates.

2.2.1.2 Ground Iron Blast-Furnace Slag

ASTM C 989, Grade 100 or 120.

[2.2.1.3 Silica Fume

****

NOTE: Use silica fume concrete for marine structures where low permeability and enhanced durability are necessary. The silica fume and high range water reducer additive should be from the same manufacturer. Select weight percentage based-on performance required.

****

****
NOTE: Use for high durability and low permeability. The initial cost of the concrete will increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume, the slump can be increased 50 to 125 mm (2 to 5 inches) 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.
****

ASTM C 1240, provide silica fume that is a by-product of silicon or ferrosilicon production. Provide [5] [7.5] [10] percent by weight of the total cementitious material.

****
NOTE: Where controlled use of silica fume is required for the project by the designer on Army projects use the below bracketed text and delete the paragraph above.
****

[Silica fume may be furnished as a dry, densified material or as a slurry. Silica fume, unprocessed, or before processing into a slurry or a densified material, shall conform to the following requirements:

a. Silicon dioxide content: 85-percent minimum, test method ASTM C 311.

b. Loss on ignition: 6.0-percent maximum, test method ASTM C 311.

c. Surface area, nitrogen adsorption, 15,000 m_2/kg minimum, test method ASTM C 1069.

d. Oversize, percent retained on 45-micrometer sieve: 5-percent maximum, test method ASTM C 430.

The Contractor shall provide at his expense the services of a manufacturer's technical representative, experienced in mixture proportioning, placement procedures, and curing of concrete containing silica fume. The manufacturer's representative shall be available for consultation by both the Contractor and the Government during mixture proportioning, planning, and production of silica-fume concrete and shall be on site immediately prior to and during at least the first placement of concrete containing silica fume and at other times, if directed.]

]2.2.2 Water

Water shall be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete, ACI 318MACI 318/318R.

2.2.3 Aggregates

2.2.3.1 Aggregates Selection

****
NOTE: Select gradation(s) based on job requirements

and constraints. The maximum aggregate size shall not exceed three-quarters the minimum cover over reinforcing. Aggregate grading sizes with their general grading ranges are as follows: Size 57 (25 mmone inch to No. 4 sieve), Size 67 (20 mm3/ 4 inch to No. 4 sieve), and Size 7 (12 mm1/2 inch to No. 4 sieve).

****

****

NOTE: If state standards are used for aggregate, fill in the appropriate State Department of Transportation and classification type.

****

ASTM C 33, Size [57] [67] [7] [_____][or the requirements of the State of [_____] Department of Transportation], except as modified herein. Obtain aggregates for exposed concrete surfaces from one source. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalies in the cement, nor in an amount sufficient to cause excessive expansion of concrete. Prior to fabrication, submit certified test reports for the following tests specified in ASTM C 33[,in addition, [twice] [____] during each shift when the concrete plant is operating, the gradation of each size of aggregate shall be tested in accordance with ASTM C 136]:

a. Grading

b. Amount of material finer than 75 micrometers No. 200 sieve

c. Organic impurities

d. Soundness

e. Clay lumps and friable particles

f. Coal and lignite

g. Weight of slag

h. Abrasion of coarse aggregate

i. Fineness modulus

j. Reactive aggregates

k. Freezing and thawing

2.2.3.2 Alkali-Silica Reactivity

****

NOTE: Use first and third tailoring options for Navy projects; use second tailoring option for Army and Air Force.

****

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity in accordance with ASTM C 1260. Test both coarse aggregate size groups if from different sources. Evaluate the fine

and coarse aggregates separately and in combination, which matches the Contractor's proposed mix design proportioning, utilizing the modified version of ASTM C 1260. Test results of the combination must have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Modify ASTM C 1260 as follows to included one of the following options:

a. Utilize the Contractor's proposed low alkali portland cement and Class F fly ash or Class N pozzolan in combination with the proposed aggregate percentage for the test proportioning. Use Class F fly ash or Class N pozzolan in the range of 25 percent to 40 percent of the total cementitious material by mass. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion equal to or less than 0.08 percent at 16 days after casting. Class C fly ash shall not be used with reactive aggregates.

b. Utilize the Contractor's proposed low alkali portland cement and ground granulated blast furnace (GGBF) slag in combination with the proposed aggregate percentage for the test proportioning. Use GGBF slag in the range of 40 percent to 50 percent of the total cementitious material by mass. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion equal to or less than 0.08 percent at 16 days.

****
NOTE: The use of Lithium Nitrate for mitigation of alkali-silica reaction is an alternative for Navy projects only. However, do not include in a project specification without Navy EFD or NFESC concurrence.
****

c. Utilize the Contractor's proposed low alkali portland cement and a lithium nitrate admixture. The lithium nitrate admixture may be used in combination with either Class "F" fly ash, Class N pozzolan, or ground granulated blast furnace (GGBF) slag, at a dosage rate as recommended by the manufacturer.

If any of the above options does not lower the expansion to less than 0.08 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

[2.2.3.3 Aggregates for Lightweight Concrete

ASTM C 330.

]2.2.4 Grout

2.2.4.1 Nonshrink Grout

ASTM C 1107/C 1107M.

2.2.4.2 Cementitious Grout

****
NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.
****

Shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. [Provide air entrainment for grout exposed to the weather.]

2.2.5 Admixtures

[2.2.5.1 Air-Entraining

****
NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.
****

ASTM C 260.

]2.2.5.2 Accelerating

ASTM C 494/C 494M, Type C or E.

2.2.5.3 Water Reducing

ASTM C 494/C 494M, Type A, E, or F.

2.2.6 Reinforcement

2.2.6.1 Reinforcing Bars

****
NOTE: Specify ASTM A 706/A 706M reinforcing where welding or bending of reinforcement bars is important. In addition in locations where reinforcing maybe subject to corrosive environmental conditions such as bridge decking use either epoxy coated reinforcement, epoxy coated prefabricated steel reinforcing bars or zinc-coated (galvanized) bars, ASTM A 775 epoxy coated reinforcing, ASTM A 934 epoxy coated prefabricated steel reinforcing bars or ASTM A 767/A 767M respectively may be specified where extra reinforcement protection is required.
****

ASTM A 615/A 615M, Grade [280] [420] [40] [60]; [ASTM A 706/A 706M, Grade 420 60;] or ASTM A 996/A 996M, Grade [350][420] [50] [60].

[Epoxy-coated steel bars shall comply with the requirements of [ASTM A 775/A 775M][ASTM A 934/A 934M], including written certifications for coating material and coated bars, sample of coating material, and 700 g 0.5 pounds of patching material.]

[Zinc-coated (galvanized) bars shall comply with the requirements of ASTM A 767/A 767M, Class [_____] coating, galvanized after fabrication.]

2.2.6.2 Wire

****
NOTE: Use ASTM A 82/A 82M for plain wire and ASTM A 496/A 496M for deformed wire.

****

ASTM A 82/A 82M or ASTM A 496/A 496M.

2.2.6.3 Welded Wire Fabric

****
NOTE: Use ASTM A 185/A 185M for welded plain steel and ASTM A 497/A 497M for welded deformed steel.
****

ASTM A 185/A 185M or ASTM A 497/A 497M.

[2.2.7 Prestressing Strands

[Uncoated, 7-wire strand stressed relieved, ASTM A 416/A 416M, Grade [250][270], strand diameter as shown.]

[Single wire stressed relieved, ASTM A 421/A 421M for low relaxation wire.]

[High-strength steel bars shall conform to ASTM A 722/A 722M, Type I or II, meeting all supplementary requirements.]

]2.2.8 Metal Accessories

Provide ASTM A 123/A 123M or ASTM A 153/A 153M galvanized.

2.2.8.1 Inserts

ASTM A 47/A 47M, Grade 22010 32510 or 35018, or ASTM A 27/A 27M Grade 415-205 U-60-30.

2.2.8.2 Structural Steel

ASTM A 36/A 36M.

2.2.8.3 Bolts

ASTM A 307; ASTM A 325M ASTM A 325.

2.2.8.4 Nuts

ASTM A 563MASTM A 563.

2.2.8.5 Washers

ASTM F 844 washers for ASTM A 307 bolts, and ASTM F 436M ASTM F 436 washers for ASTM A 325M ASTM A 325bolts.

2.2.9 Bearing Pads

2.2.9.1 Elastomeric

AASHTO HB-17, for plain neoprene bearings.

2.2.9.2 Hardboard (Interior Only)

AHA A135.4, class as specified by the precast manufacturer.

2.2.10 Grout

2.2.10.1 Cementitious Grout

Shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

2.2.10.2 Nonshrink Grout

Nonshrink grout shall conform to ASTM C 1107/C 1107M and shall be a commercial formulation suitable for the application proposed.

2.3 PRODUCTION QUALITY CONTROL PROCEDURES

****
NOTE: Refer to PCI for tolerance information. Modify to add critical tolerance if different than PCI.
****

PCI MNL-116 unless specified otherwise.

2.3.1 Forms

Brace forms to prevent deformation. Forms shall produce a smooth, dense surface. Chamfer exposed edges of columns and beams 200 mm 3/4 inch, unless otherwise indicated. Provide threaded or snap-off type form ties.

2.3.2 Reinforcement Placement

ACI 318MACI 318/318R for placement and splicing. Reinforcement may be preassembled before placement in forms. Provide exposed connecting bars, or other approved connection methods, between precast [prestressed]and cast-in-place construction. Remove any excess mortar that adheres to the exposed connections.[Provide curvature or drape of the prestressing strands using approved hold-down devices.]

[2.3.3 Inserts

When the ends of the prestressed member will be exposed, recess the prestressing stands using inserts. After detensioning, remove inserts and fill the recess with nonshrink grout.

]2.3.4 Concrete

2.3.4.1 Concrete Mixing

ASTM C 94/C 94M. Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

2.3.4.2 Concrete Placing

ACI 304R[, ACI 305R for hot weather concreting] [, ACI 306.1 for cold weather concreting,] and ACI 309R, unless otherwise specified.

2.3.4.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing. Provide curing procedures to keep the temperature of the concrete between 10 and 90 degrees C 50 and 190 degrees F. When accelerated curing is used, apply heat at controlled rate and uniformly along the casting beds. Monitor temperatures at various points in a product line in different casts.

[2.3.5 Prestressing

****
NOTE: For normal prestressing use a release strength of 23 MPa 3500 psi, unless the design requires a higher release strength. Some release strengths are indicated in the PCI Design Handbook for selected prestressed members based on different load conditions, strand patterns, and span lengths.
****

Do not transfer prestressing forces during detensioning until the concrete has reached a minimum compressive strength of [24 MPa] [3500 psi] [_____], unless a higher strength is required by the Contractor furnished design.

]2.3.6 Surface Finish

Repairs located in a bearing area shall be approved by the Contracting Officer prior to repairs. [Prestressed members which contain honeycombed sections deep enough to expose prestressing strands shall be rejected.]Precast [prestressed]members containing hairline cracks which are visible and are less than 0.25 mm 0.01 inches in width, may be accepted, except that cracks larger than 0.1 mm 0.005 inches in width for surfaces exposed to the weather shall be repaired. Defects that involve more than 900 mm^2 36 square inches of concrete shall be grounds for rejection. Any precast[prestressed] member that is structurally impaired or contains honeycombed section deep enough to expose stressing tendons or reinforcing shall be rejected. Defects shall be repaired or rejected as specified in paragraph "Defects."

2.3.6.1 Unformed Surfaces

Provide a [floated] [steel troweled] finish.

2.3.6.2 Formed Surfaces

****
NOTE: PCI MNL-116 different grades of formed surface finishes:

Commercial Grade: Concrete produced in forms that produce a rough finish. Fins are removed and large surface blemishes filled. Sharp edges that will be visible in the finished structure are ground down.

Standard Grade: Same finish as commercial grade, except the forms do not produce a texture on the concrete. Surface can be painted, but will have surface voids.

Finish Grade B: Same as standard grade, except all surface blemishes should be filled or finished to provide a smooth surface or uniform appearance if painted.

Finish Grade A: Same as Finish Grade B, except that the components of the completed structure, where exposed, shall be reasonably color matched. This finish is difficult to obtain.

****

PCI MNL-116 (Appendix A - Commentary), Chapter 3, for grades of surface finishes.

a. Unexposed Surfaces: Provide a [commercial] [standard] grade surface finish.

b. Exposed Surfaces: Provide a [standard grade] [finish Grade B] [_____] surface finish. [The combined area of acceptable defective areas shall not exceed 0.2 percent of the exposed to view surface area, and the patches shall be indistinguishable from the surrounding surfaces when dry.] [In addition to a Grade B surface finish, members shall have a smooth rubbed finish.]

2.3.6.3 Architectural Finish

Provide a [finish Grade A] [_____] surface finish to those members indicated.

2.3.7 Acceptance/Rejection of Defects

2.3.7.1 Minor Defects

All honeycombed areas, chipped corners, air pockets over 6 mm 1/4 inch in diameter, and other minor defects involve less than 900 mm^2 36 square inches of concrete shall be repaired. Form offsets of fins over 3 mm 1/8 inch shall be ground smooth. All unsound concrete shall be removed from defective areas prior to repairing. All surfaces permanently exposed to view shall be repaired by a blend of portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete.

2.3.7.2 Major Defects

Major defects are those which involve more than 900 mm^2 36 square inches of concrete or expose stressing tendons or reinforcing steel. If one or more major defects appear in a member, it shall be rejected. Cracks of a width of more than 0.25 mm 0.01 inch shall be cause for rejection of the member.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

****

NOTE: If marine environment or exposed to severe environmental conditions, recommend including chloride ion penetration requirements.

****

[2.4.1 Chloride Ion Concentration Test

Sampling and determination of water soluble chloride ion content in accordance with ASTM C 1218/C 1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed 0.06 percent by weight of cement.

][2.4.2 Chloride Ion Penetration Test

To ensure the durability of concrete in marine environment, concrete shall be proportioned to have the chloride ion penetration test in accordance with ASTM C 1202, and be below 1500 coulombs for concrete specimens tested at 28 days. [Alternatively, a ponding test in accordance with AASHTO T 259 may be performed to validate chloride ion penetration in accordance with ASTM C 1202.]

]2.4.3 Factory Inspection

****
NOTE: Check with the designer and Resident in Charge of Construction and edit appropriately.
****

At the option of the Contracting Officer, [precast[prestressed] units may be inspected by the Contracting Officer] [precast[prestressed] units shall be inspected by the QC Representative] prior to being transported to the job site. The Contractor shall 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.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to erection, and again after installation, precast[prestressed] members shall be checked for damage, such as cracking, spalling, and honeycombing. As directed by the Contracting Officer, precast[prestressed] members that do not meet the surface finish requirements specified in Part 2 in paragraph entitled "Surface Finish" shall be repaired, or removed and replaced with new precast [prestressed]members.

3.2 ERECTION

Precast [prestresed]members shall be erected after the concrete has attained the specified compressive strength, unless otherwise approved by the precast[prestressing] manufacturer. [In addition, prestressed members shall not be rigidly fixed in position until the prestressed member has "aged" [90] [_____] days after detensioning.] Erect in accordance with the approved shop drawings. PCI MNL-116 and PCI MNL-120 (Chapter 8), for tolerances. Provide a 1:500 tolerance, if no tolerance is specified. Brace precast [prestressed]members, unless design calculations submitted with the shop drawings indicate bracing is not required. Follow the manufacturer's recommendations for maximum construction loads. Place precast[prestressed] members level, plumb, square, and true within tolerances. Align member ends.

3.3 BEARING SURFACES

Shall be flat, free of irregularities, and properly sized. Size bearing surfaces to provide for the indicated clearances between the precast[prestressed] member and adjacent precast[prestressed] members or adjoining field placed surfaces. Correct bearing surface irregularities with nonshrink grout. Provide bearing pads where indicated or required. Do not use hardboard bearing pads in exterior locations. Place precast[prestressed] members at right angles to the bearing surface, unless indicated otherwise, and draw-up tight without forcing or distortion, with sides plumb.

3.4 ANCHORAGE

Provide anchorage for fastening work in place. Conceal fasteners where practicable. Make threaded connections up tight and nick threads to prevent loosening.

3.5 WELDING

AWS D1.4/D1.4M for welding connections and reinforcing splices. [Do not weld prestressing strands.]Protect the concrete and other reinforcing from heat during welding. Weld continuously along the entire area of contact. Grind smooth visible welds in the finished installation. Welding of epoxy-coated reinforcing is not allowed.

3.6 OPENINGS

Holes or cuts requiring [reinforcing][prestressing steel]to be cut, which are not indicated on the approved shop drawing, shall only be made with the approval of the Contracting Officer and the precast manufacturer. Drill holes less than 300 mm12 inches in diameter with a diamond tipped core drill.

3.7 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A 780 zinc rich paint for galvanized surfaces damaged by handling, transporting, cutting, welding, bolting, or acid washing. Do not heat surfaces to which repair paint has been applied.

3.8 GROUTING

Clean and fill [indicated] keyways between precast[prestressed] members, and other indicated areas, solidly with nonshrink grout or cementitious grout. Provide reinforcing where indicated. Remove excess grout before hardening.

3.9 SEALANTS

Provide as indicated and as specified in Section 07 92 00, "Joint Sealants."

[3.10 CONCRETE TOPPING

Provide as indicated and as specified in [Section 03 30 00.00 20, "Cast-In-Place Concrete."][Section 03 31 00.00 10, "Cast-In-Place Structural Concrete."][Section 03 31 01.00 10, "Cast-In-Place Sructural Concrete for Civil Works."]

][3.11 CONSTRUCTION RECORDS

Complete construction records shall be kept of the manufacturing, handling, and erection of the precast-prestressed concrete members. Records shall be kept for, but not limited to, the following items:

a. Specifications of material used in the manufacture of the members.

b. Time-temperature history of the concrete members from casting to the transfer of the prestress force.

c. Records of the tendon stressing operation including initial prestress force, measured elongation, how it was measured, and how the tendons were stressed and destressed.

d. Records of inspection of the members before and after the prestress force is transferred to the members.

e. Records of the inspection of the members each time they are moved.

f. Records of any defects in the member and any corrective measures taken.

] -- End of Section --