
USACE / NAVFAC / AFCEC

UFGS-03 45 33 (May 2016)

Change 1 - 11/21

Preparing Activity: NAVFAC

Superseding

UFGS-03 45 33 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2025

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SECTION 03 45 33

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SECTION 03 45 33

PRECAST STRUCTURAL CONCRETE
05/16, CHG 1: 11/21

NOTE: This guide specification covers the requirements for precast non-prestressed and precast concrete used for structural purposes and for minor architectural purposes in building construction.

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 item(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).

NOTE: This guide specification does not cover precast concrete wall panels (Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE), major precast non-prestressed architectural concrete, post tensioned concrete, or precast concrete which is site manufactured and must 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.

NOTE: The following information must 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. Layout of the framing system indicating the relative location of the various precast structural concrete sections, floor elevations, column centers and offsets, openings, and sufficient dimensions to adequately convey the quantity and nature of the required precast structural concrete framing system.

5. Details of all precast structural concrete sections indicating cross-sections and dimensions.

6. Location of precast structural concrete sections having an architectural finish on exposed-to-view surfaces when required.

7. Details of openings including the size of steel framing members as required.

8. Style and area of steel welded wire reinforcement in areas where required. Kind and size of reinforcing bars and spacing.

9. Strength and type of concrete.

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

11. Fire rating.

12. Lightweight concrete unit weight.

13. Special requirements for concrete cover over reinforcing.

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

15. Camber.

16. 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 Reference Identifier (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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

- | | |
|-----------------|---|
| AASHTO LRFDCONS | (3rd Edition; 2010, 2011, 2012, 2014, 2015, and 2016 Int) Bridge Construction Specifications |
| AASHTO M 251 | (2006; R 2011) Standard Specification for Plain and Laminated Elastomeric Bridge Bearings |
| AASHTO T 259 | (2002; R 2017) Standard Method of Test for Resistance of Concrete to Chloride Ion Penetration |

AMERICAN CONCRETE INSTITUTE (ACI)

- | | |
|----------|---|
| ACI 318M | (2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary |
|----------|---|

AMERICAN HARDBOARD ASSOCIATION (AHA)

- | | |
|------------|--------------------------------|
| AHA A135.4 | (1995; R 2004) Basic Hardboard |
|------------|--------------------------------|

AMERICAN WELDING SOCIETY (AWS)

- | | |
|----------------|--|
| AWS D1.1/D1.1M | (2025) Structural Welding Code - Steel |
| AWS D1.4/D1.4M | (2018) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

- | | |
|---------------|---|
| ASTM A27/A27M | (2020) Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2023) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A767/A767M	(2024) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C94/C94M	(2025) Standard Specification for

Ready-Mixed Concrete

ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C260/C260M	(2024) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2025a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2025) Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D2240	(2015; R 2021) Standard Test Method for Rubber Property - Durometer Hardness

ASTM D5759 (2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses

ASTM F436M (2011) Hardened Steel Washers (Metric)

ASTM F844 (2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116 (2021) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition

PCI MNL-120 (2021) PCI Design Handbook - Precast and Prestressed Concrete, 8th Edition

PCI MNL-124 (2011) Design for Fire Resistance of Precast Prestressed Concrete, Third Edition

PCI MNL-135 (2000) Tolerance Manual for Precast and Prestressed Concrete Construction

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-882 (1989; Rev E) Cloth, Duck, Cotton or Cotton-Polyester Blend, Synthetic Rubber, Impregnated, and Laminated, Oil Resistant

UL SOLUTIONS (UL)

UL Fire Resistance (2014) Fire Resistance Directory

KOREAN INDUSTRIAL STANDARDS (KS)

KS B 1002 (2021) Hexagon Head Bolts and Hexagon Head Screws

KS B 1010 (2022) Set of High Strength Hexagon Bolt, Hexagon Nut and Plain Washers for Friction Grip Joints

KS B 1326 (2021) Plain Washers

KS D 3504 (2025) Steel Bars for Concrete Reinforcement

KS D 3515 (2018; R 2023) Rolled Steels for Welded Structures

KS D 7017 (2023) Welded Wire Mesh and Bar Fabrics

KS F 2527 (2024) Aggregates for Concrete

KS F 2546 (2024) Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate

Combinations (Mortar-Bar Method)

KS F 2560	(2019; R 2024) Chemical Admixtures for Concrete
KS F 2563	(2020; R 2024) Ground Granulated Blast-Furnace Slag for Use in Concrete
KS F 4009	(2024) Ready-Mixed Concrete
KS F 4044	(2024) Non-ShrinkHydraulic Cement Grout
KS L 5201	(2021) Portland Cement
KS L 5405	(2023) Fly Ash

1.2 MODIFICATION TO REFERENCE

In the ACI publications, reference to the "Building Official," the "Structural Engineer" and the "Architect/Engineer" must be interpreted to mean the Contracting Officer.

1.3 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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 and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification 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

Drawings of Precast Members; G

SD-03 Product Data

Anchorage and Lifting Inserts and devices

Bearing Pads

SD-04 Samples

[Surface Finish

] SD-05 Design Data

Precast Concrete Members Design Calculations; G

Concrete Mix Design; G

SD-06 Test Reports

Concrete Mix Design; G

Fly Ash

Pozzolan

[Ground Granulated Blast-Furnace Slag

][Aggregates

][Concrete and Aggregate Quality Control Testing

][Water

] SD-07 Certificates

Quality Control Procedures

[Construction Records; G

][Epoxy-Coated Steel Bars

] SD-11 Closeout Submittals

Concrete Batch Ticket Information

Recycled Content for Fly Ash and Pozzolan; S

Recycled Content for Ground Iron Blast-Furnace Slag; S

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 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. 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.

1.4.1.2 Erector Qualifications

NOTE: Use the following paragraph when a PCI Certified erector is not available in the project location.

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

1.4.1.3 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.

1.4.2 Regulatory Requirements

NOTE: Modify to add any local codes and regulations.

Provide precast members in conformance with ACI 318M and PCI MNL-120.

1.4.3 Concrete Mix Design

NOTE: Normal precast design is based on concrete having a compressive strength of 35 MPa 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 318M. The minimum compressive strength of concrete at 28 days must be 35 MPa, 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 must be 0.40].

Sixty 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, complementary cementitious materials, and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, complementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. For previously approved concrete mix designs used within the past twelve months, the previous mix design may be re-submitted without further trial batch testing if accompanied by material test data conducted within the last six months. Obtain mix design approval from the contracting officer prior to concrete placement.

1.4.4 Certificates: Record Requirement

ASTM C94/C94M or KS F 4009. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Transportation

1.5.1.1 Transporting Members

Transport members in a manner to avoid excessive stresses that could cause cracking or other damage.

1.5.1.2 Lateral Deflection or Vibration

Any noticeable indication of lateral deflection or vibration during

transportation must be corrected by rigid bracing between members or by means of lateral trussing.

1.5.2 Storage

1.5.2.1 Storage Areas

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

1.5.2.2 Stacked Members

Stack members with adequate dunnage and bracing to control cracking, distortion, warping or other physical damage. Stack members such that lifting devices will be accessible and undamaged.

1.5.3 Handling of Members

The location of pickup points for handling of the members and details of the pickup devices must be shown in shop drawings. Members must be handled only by means of approved devices at designated locations. Members must 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 SYSTEM DESCRIPTION

The work includes the provision of precast non-prestressed concrete herein referred to as precast members. Precast members must be the product of a manufacturer specializing in the production of precast concrete members.

NOTE: When concrete toppings are indicated, they are normally allowed to be used in establishing the design strength of the precast 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 members.

2.1.1 Design Requirements

Design precast members in accordance with **ACI 318M** and the **PCI MNL-120**. Design precast 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 members for handling without cracking in accordance with the **PCI MNL-120**.

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 members should also consider the effects

**of initial handling and erection stress in the
final design of the elements.**

2.1.1.1 Loads

Loadings for members and connections must 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.

2.1.1.2 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 member. Include a cover page with the design calculations, signed and sealed by the registered design professional who prepared the design. Drawings must not be reproductions of contract drawings. Design calculations, [drawings of precast members](#) (including connections) must be made by a registered professional engineer experienced in the design of precast concrete members, and submitted for approval prior to fabrication. The drawings must 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.
- (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) 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. Strength properties for concrete, steel and other materials.

d. Methods for storage and transportation.

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

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

g. Signature and seal of the registered design professional who prepared the design.

2.1.2 Performance Requirements

NOTE: Edit when precast 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 members where indicated must have a fire rating as indicated in accordance with [UL Fire Resistance](#), or as designed in accordance with [PCI MNL-124](#).

2.2 MATERIALS

2.2.1 Material Sustainability Criteria

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section [01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING](#):

a. [Recycled content for fly ash and pozzolan](#)

b. [Recycled content for Ground Iron Blast-Furnace Slag](#)

2.2.2 Cementitious Materials

NOTE: Acceptable types of cement are as follows:

ASTM C150/C150M or KS L 5201	ASTM C595/C595M Blended	Use
Type I	Type IP, IS, IL, or IT	For general use in construction

ASTM C150/C150M or KS L 5201	ASTM C595/C595M Blended	Use
Type II	Type IP, IS, IL, or IT (MS) or (MH)	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.
Type III	Type IP, IS, IL, or IT (HE)	For use when high early strength is required. ASTM C595/C595M (blended hydraulic cements): add the suffix HE where high early strength is required. Confer with the agency's Subject Matter Expert in Concrete Materials before specifying High early strength cement.
Type V	Type IP, IS, IL, or IT (HS)	For use when high sulfate resistance is required. ASTM C595/C595M (blended hydraulic cements): add the suffix HS where high sulfate resistance is required.

For concrete subjected to salt water, near salt water or exposed to alkali/sulfate soils refer to specification Section 03 31 30 MARINE CONCRETE for additional criteria.

NOTE: For NAVFAC LANT: Typically allow Type II, IP (MS), or IS (MS). May use Type I if Type II not locally available and no sulfate problems expected (i.e., not near seawater or sulfate soils). Type III is for high early strength. Type V, IP (HS), IS (HS), IL (HS), and IT (HS) are for high sulfate resistance.

NOTE: Coal fly ash, slag, cenospheres are EPA designated products to be ingredients in concrete

and cement. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING and include additive options unless designer determines that justification for non-use exists.

For exposed concrete, use one manufacturer and one source for each type of cement, ground slag, fly ash, and pozzolan.

2.2.2.1 Fly Ash

NOTE: Fly ash, pozzolan, 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 end results. It is suggested that fly ash be used as a replacement for 35 percent of the cement. Class C fly ash is not permitted.

ASTM C618 or KS L 5405, Class F, except that the maximum allowable loss on ignition must not exceed 6 percent.

Add with cement. Fly ash content must be a minimum of 15 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permissible that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.2.2.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

2.2.2.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

- a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.
- b. The average particle size must not exceed 6 microns.
- c. The sum of SiO₂ + Al₂O₃ + Fe₂O₃ must be greater than 77 percent.

2.2.2.4 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M or KS F 2563. Slag content must be a minimum of 25 percent by weight of cementitious material.

2.2.2.5 Portland Cement

NOTE: If high early strength concrete is required, specify Type III after consulting the agency's Subject Matter Expert in Concrete Materials.

When concrete is exposed to sea water use specification Section 03 31 30 MARINE CONCRETE.

When high-volume fly ash mixtures, mixtures where fly ash replacement of portland cement is greater than 50 percent by weight, are specified they may be blended with Type II or Type III cement for higher early strength. Consult the agency's Subject Matter Expert in Concrete Materials prior to using Type III cement.

Provide cement that conforms to ASTM C150/C150M or KS L 5201, Type I or II, with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na₂O_e (sodium oxide) equivalent. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that no hazardous waste is used in the fuel mix or raw materials. Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged.

2.2.2.6 Blended Cements

- a. Blended cements must conform to ASTM C595/C595M Type IP or IS.
- b. Slag cement added to the Type IS blend must meet ASTM C989/C989M.
- c. The pozzolan added to the Type IP blend must be ASTM C618 Class F or KS L 5405, and must be interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.2.3 Water

Water must comply with the requirements of ASTM C1602/C1602M or KS F 4009, Appendix B. Minimize the amount of water in the mix. Improve workability by adjusting the grading rather than by adding water. Water must be [potable][from rainwater collection][from graywater][from recycled water]; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete. Submit test report showing water complies with ASTM C1602/C1602M or KS F 4009, Appendix B.

2.2.4 Aggregates

ASTM C33/C33M or KS F 2527, except as modified herein. Furnish aggregates

for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalis in the cement. Submit test report showing compliance with [ASTM C33/C33M](#) or [KS F 2527](#).

Fine and coarse aggregates must show expansions less than 0.08 percent at 28 days after casting when testing in accordance with [ASTM C1260](#) or [KS F 2546](#). Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using [ASTM C1567](#) using the Contractor's proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

- a. GGBF slag at a minimum of 40 percent of total cementitious
- b. Fly ash or natural pozzolan at a minimum of total cementitious of
 - (1) 30 percent if (SiO₂ plus Al₂O₃ plus Fe₂O₃) is 65 percent or more,
 - (2) 25 percent if (SiO₂ plus Al₂O₃ plus Fe₂O₃) is 70 percent or more,
 - (3) 20 percent if (SiO₂ plus Al₂O₃ plus Fe₂O₃) is 80 percent or more,
 - (4) 15 percent if (SiO₂ plus Al₂O₃ plus Fe₂O₃) is 90 percent or more.

If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 28 days after casting when tested in accordance with [ASTM C1567](#).

Aggregates must not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with [ASTM C295/C295M](#).

[2.2.4.1 Aggregates for Lightweight Concrete

[ASTM C330/C330M](#) or [KS F 2527](#).

]2.2.5 Grout

2.2.5.1 Nonshrink Grout

[ASTM C1107/C1107M](#) or [KS F 4044](#).

2.2.5.2 Cementitious Grout

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

Must 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.]

2.2.6 Admixtures

[2.2.6.1 Air-Entraining

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

ASTM C260/C260M or KS F 2560.

]2.2.6.2 Accelerating

ASTM C494/C494M, Type C or E; or KS F 2560.

2.2.6.3 Water Reducing

ASTM C494/C494M, Type A, E, or F; or KS F 2560.

2.2.7 Reinforcement

2.2.7.1 Reinforcing Bars

NOTE: Specify ASTM A706/A706M 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 A775/A775M epoxy coated reinforcing, ASTM
A934/A934M epoxy coated prefabricated steel
reinforcing bars or ASTM A767/A767M respectively may
be specified where extra reinforcement protection is
required.

ASTM A615/A615M or KS D 3504, Grade [280] [420]; [ASTM A706/A706M, Grade
420;] or ASTM A996/A996M, Grade [350][420].

[Epoxy-coated steel bars must comply with the requirements of [
ASTM A775/A775M][ASTM A934/A934M], including written certifications for
coating material and coated bars, sample of coating material, and 700 g of
patching material. Submit written certification with the delivery of the
bars.

][Zinc-coated (galvanized) bars must comply with the requirements of
ASTM A767/A767M, Class II coating, galvanized after fabrication.

]2.2.7.2 Wire

ASTM A1064/A1064M.

2.2.7.3 Welded Wire Reinforcement

ASTM A1064/A1064M or KS D 7017.

2.2.7.4 Supports for Concrete Reinforcement

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

Ensure legs of supports in contact with formwork for sections that will be exposed to weather are hot-dip galvanized after fabrication, plastic coated, or corrosion-resistant steel bar supports.

2.2.8 Metal Accessories

Provide [ASTM A123/A123M](#) or [ASTM A153/A153M](#) galvanized.

2.2.8.1 Inserts

[ASTM A47/A47M](#), Grade [22010](#), or [ASTM A27/A27M](#) Grade [415-205](#). Submit product data.

2.2.8.2 Structural Steel

[ASTM A36/A36M](#) or [KS D 3515](#).

2.2.8.3 Bolts

[ASTM A307](#) or [KS B 1002](#); [ASTM A325M](#) or [KS B 1010](#).

2.2.8.4 Nuts

[ASTM A563M](#) or [KS B 1010](#).

2.2.8.5 Washers

[ASTM F844](#) or [KS B 1326](#) washers for [ASTM A307](#) or [KS B 1002](#) bolts, and [ASTM F436M](#) or [KS B 1010](#) washers for [ASTM A325M](#) or [KS B 1010](#) bolts.

2.2.9 Bearing Pads

Submit product data for all bearing pads being used.

2.2.9.1 Elastomeric

[AASHTO M 251](#), for plain neoprene bearings.

2.2.9.2 Hardboard (Interior Only)

[AHA A135.4](#), class as specified by the precast manufacturer.

2.2.9.3 Random-Oriented, Fiber-Reinforced Elastomeric Pads

Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to [ASTM D2240](#). Capable of supporting a compressive stress of [20.7 Mpa](#) with no cracking, splitting or delaminating in the internal portion of the pad.

2.2.9.4 Cotton-Duck-Fabric-Reinforced Elastomeric Pads

Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to [ASTM D2240](#). Conforming to Division II, Section 18.10.2 of [AASHTO LRFD CONS](#)

Bridge Design Specifications or Military Specification **MIL-C-882**.

2.2.9.5 Frictionless Pads

Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, of type required for in-service stress.

2.2.9.6 High-Density Plastic

Multimonomer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.

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

2.3.1 Forms

Brace forms to prevent deformation. Forms must produce a smooth, dense surface. Use forms and form-facing materials that are nonreactive with concrete such as wood, metal, plastic, or other approved materials. Conform to the shapes, lines, and dimensions indicated and are within the limits of the specified fabrication tolerances. Chamfer exposed edges of columns and beams **200 mm**, unless otherwise indicated. Provide threaded or snap-off type form ties.

2.3.2 Tolerances

Fabricate structural precast concrete members of shapes, lines and dimensions indicated, so each finished member complies with **PCI MNL-135** product tolerances as well as position tolerances for cast-in items.

2.3.3 Reinforcement Placement

ACI 318M and **PCI MNL-116** for placement and splicing. Place and secure steel bars, welded-wire reinforcement, and other reinforcement by means of metal bar supports and spacers. Reinforcement may be preassembled before placement in forms. Provide exposed connecting bars, or other approved connection methods, between precast and cast-in-place construction. Remove any excess mortar that adheres to the exposed connections.

2.3.4 Built-In Anchorage Devices

**NOTE: Indicate anchorage devices that are to be
embedded in the precast structural concrete
sections. Anchorage devices include weld plates,
bearing plates and steel shapes.**

Position, anchor, and locate anchorage devices where they do not affect

the position of the main reinforcement or placing concrete. Bearing plates; set level, aligned properly, and anchored in the exact location indicated.

2.3.5 Lifting Devices

Provide lifting devices designed for 100-percent impact, and of materials sufficiently ductile to ensure visible deformation before fracture.

2.3.6 Blockouts

NOTE: Blockouts or openings in slabs that would require the cutting of primary reinforcement if such openings were to be cut in the field ensure openings are cast in the unit during fabrication and indicated. The maximum size of field-cut openings may be from 150 to 300 millimeter depending on the type of unit used such as the inside diameter of the voids in hollow core flat slabs and the spacing of reinforcement.

Provide blockouts as indicated.

2.3.7 Identification Markings

Clearly mark each structural section in a permanent manner to indicate its location and orientation in the building and the pickup points.

Ensure each structural section has the date of casting plainly indented in the unexposed face of the concrete.

2.3.8 Concrete

2.3.8.1 Concrete Mixing

ASTM C94/C94M or KS F 4009. Mixing operations must produce batch-to-batch uniformity of strength, consistency, and appearance.

2.3.8.2 Concrete Placing

PCI MNL-116.

2.3.8.3 Concrete Curing

PCI MNL-116.

2.3.9 Surface Finish

Repairs located in a bearing area must be approved by the Contracting Officer prior to repairs. Defects must be repaired or rejected as specified in paragraph ACCEPTANCE/REJECTION OF DEFECTS.

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

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

2.3.9.1 Unformed Surfaces

Provide a [floated] [steel troweled] finish.

2.3.9.2 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, must be reasonably color matched. This finish is difficult to obtain.

PCI MNL-116, Appendix C, 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 must not exceed 0.2 percent of the exposed to view surface area, and the patches must be indistinguishable from the surrounding surfaces when dry.][In addition to a Grade B surface finish, members must have a smooth rubbed finish.]

2.3.9.3 Architectural Finish

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

2.3.10 Acceptance/Rejection of Defects

2.3.10.1 Minor Defects

All honeycombed areas, chipped corners, air pockets over 6 mm in diameter, and other minor defects involve less than 900 mm² of concrete must be repaired. Form offsets of fins over 3 mm must be ground smooth. All

unsound concrete must be removed from defective areas prior to repairing. All surfaces permanently exposed to view must 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. Precast members containing hairline cracks which are visible and are less than 0.25 mm in width, may be accepted, except that cracks larger than 0.1 mm in width for surfaces exposed to the weather must be repaired.

2.3.10.2 Major Defects

Major defects are those which involve more than 900 mm² of concrete or expose stressing tendons or reinforcing steel. If one or more major defects appear in a member, it will be rejected. Cracks of a width of more than 0.25 mm will 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 C1218/C1218M. 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 must 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 must be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, 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 C1202.]

] 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 units must be inspected by the QC Representative prior to being transported to the job site. The Contractor must 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 members must be

checked for damage, such as cracking, spalling, and honeycombing. As directed by the Contracting Officer, precast members that do not meet the surface finish requirements specified in paragraph SURFACE FINISH must be repaired, or removed and replaced with new precast members.

3.2 ERECTION

Precast members must be erected after the concrete has attained the specified compressive strength, unless otherwise approved by the precast manufacturer. Erect in accordance with the approved shop drawings. **PCI MNL-135** for tolerances. Provide a 1:500 tolerance, if no tolerance is specified. Brace precast 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 members level, plumb, square, and true within tolerances. Align member ends.

3.3 BEARING SURFACES

Must be flat, free of irregularities, and properly sized. Size bearing surfaces to provide for the indicated clearances between the precast member and adjacent precast 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 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 D1.1/D1.1M, **AWS D1.4/D1.4M** for welding connections and reinforcing splices. 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 to be cut, which are not indicated on the approved shop drawing, must only be made with the approval of the Contracting Officer and the precast manufacturer. Drill holes less than **300 mm** in diameter with a diamond tipped core drill. Ensure cuts are straight and at 90 degrees to the surfaces without breaking or spalling the edges.

3.7 GALVANIZING REPAIR

Repair damage to galvanized coatings using **ASTM A780/A780M** 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 keyways between precast 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 PROTECTION AND CLEANING

NOTE: Ensure where architectural finishes such as exposed-aggregate finish are specified for exposed-to-view surfaces, such surfaces are cleaned as specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

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

Upon completion of installation, swept clean and leave ready slab surfaces to receive concrete floor topping, roofing, or other covering.

[3.11 CONCRETE TOPPING

Provide as indicated and as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

] [3.12 CONSTRUCTION RECORDS

Complete construction records must be kept of the manufacturing, handling, and erection of the precast-prestressed concrete members and submitted. Records must 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 --