

GUIDE SPECIFICATION FOR PLANT-PRECAST CONCRETE PRODUCTS

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NOTE: This guide specification covers the requirements for plant manufactured precast concrete products.

Comments and suggestions regarding this specification are welcome and should be directed to the NPCA Technical Services Department.

Please visit the NPCA Web site at www.precast.org.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1: GENERAL

1.1 REFERENCES

Where applicable, the latest editions of the following standards shall form a part of this specification to the extent referenced. The publications are referenced to in the text of this guide specification by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

Standard Specifications for Highway Bridges

Guide Specifications for Structural Design of Sound Barriers

Standard Specification for Transportation Materials and Methods of Sampling and Testing

ACI INTERNATIONAL (ACI)

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

ACI 211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete

ACI 211.3	Guide for Selecting Proportions for No-Slump Concrete
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 309R	Consolidation of Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 517.2R	Accelerated Curing of Concrete at Atmospheric Pressure

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

ACPA Concrete Pipe Handbook
ACPA Design Manual

ASTM INTERNATIONAL (ASTM)

ASTM A 36	Specification for Carbon Structural Steel
ASTM A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184	Specification for Fabricated Deformed Steel Mats for Concrete Reinforcement
ASTM A 185	Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 496	Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 706	Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 767	Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A 775	Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A 884	Specification for Epoxy-Coated Steel and Welded Wire Fabric for Reinforcement
ASTM C 14	Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Specification for Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 42	Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C 76	Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
ASTM C 78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 94	Specification for Ready-Mixed Concrete
ASTM C 117	Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	Standard Test Method for Lightweight Particles in Aggregate

ASTM C 125	Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138	Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 143	Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173	Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method
ASTM C 192	Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete
ASTM C 330	Specification for Lightweight Aggregates for Structural Concrete
ASTM C 361	Specification for Reinforced Concrete Low-Head Pressure Pipe
ASTM C 403	Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C 443	Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete

ASTM C 497	Test Methods for Concrete Pipe, Manhole Sections, or Tile
ASTM C 506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C 507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C 566	Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 595	Specification for Blended Hydraulic Cements
ASTM C 617	Standard Practice for Capping Cylindrical Concrete Specimens
ASTM C 618	Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 666	Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 685	Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 805	Test Method for Rebound Number of Hardened Concrete
ASTM C 822	Standard Terminology Relating to Concrete Pipe and Related Products
ASTM C 825	Specification for Precast Concrete Barriers
ASTM C 857	Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C 858	Specification for Underground Precast Concrete Utility Structures
ASTM C 877	Specification for External Sealing Bands for Concrete Pipe, Manholes and Precast Box Sections

ASTM C 890	Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 891	Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C 913	Specification for Precast Concrete Water and Wastewater Structures
ASTM C 915	Specification for Precast Reinforced Concrete Crib Wall Members
ASTM C 920	Specification for Elastomeric Joint Sealants
ASTM C 923	Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
ASTM C 924	Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C 979	Specification for Pigments for Integrally Colored Concrete
ASTM C 985	Standard Specification for Nonreinforced Concrete Specified Strength Culvert, Storm Drain, and Sewer Pipe
ASTM C 990	Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C 1018	Test Method for Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)
ASTM C 1037	Practice for Inspection of Underground Precast Concrete Utility Structures
ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

ASTM C 1116	Standard Specification for Fiber-Reinforced Concrete and Shotcrete
ASTM C 1582	Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete
ASTM C 1214	Standard Test Method for Concrete Pipe Sewerlines by Negative Air Pressure (Vacuum) Test Method
ASTM C 1227	Standard Specification for Precast Concrete Septic Tanks
ASTM C 1231	Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C 1240	Standard Specification for Use of Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
ASTM C 1244	Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM C 1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 1293	Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C 1399	Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete
ASTM C 1433	Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers
ASTM C 1478	Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals
ASTM C 1504	Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts, Storm Drains
ASTM C 1550	Standard Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)

ASTM C 1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C 1603	Standard Test Method for Measurement of Solids in Water
ASTM C 1611	Standard Test Method for Slump Flow of Self-Consolidating Concrete
ASTM C1613	Standard Specification for Precast Concrete Grease Interceptors
ASTM D 2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM G 109	Standard Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments

AMERICAN WELDING SOCIETY (AWS)

AWS D 1.1	Structural Welding Code - Steel
AWS D 1.4	Structural Welding Code - Reinforcing Steel

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

Manual of Standard Practice
Placing Reinforcing Bars

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

NPCA QC Manual	Quality Control Manual for Precast Concrete Plants
NPCA Selected ASTM Standards	ASTM Standards for Precast Concrete

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

MNL-120	PCI Design Handbook
MNL-122	Architectural Precast Concrete

1.2 GENERAL REQUIREMENTS

Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously

engaged in the manufacture of precast concrete units similar to that indicated in the project specifications or drawings for at least [] years.

1.3 SUBMITTALS

The following items may be submitted upon request by the customer.

1.3.1 Preconstruction Submittals

Submit quality control procedures established by the precast manufacturer in accordance with the NPCA Quality Control Manual for Precast Concrete Plants.

1.3.2 Shop Drawings

Drawings for Standard Precast Concrete Units

The drawings for standard precast concrete units shall be shop drawings furnished by the precast concrete producer for approval by the customer. These drawings shall demonstrate that the applicable industry design standards have been met. Installation and construction information shall be included on shop drawings upon request. Details of steel reinforcement size and placement as well as supporting design calculations, if appropriate, shall be included. The precast concrete units shall be produced in accordance with the approved drawings. Drawings shall indicate assumptions used in the design of standard units. It is the responsibility of the project's engineer-of-record to verify that the design assumptions are suitable for the proposed application.

Drawings for Custom-Made Precast Concrete Units

The drawings for custom-made precast concrete units shall be shop drawings furnished by the precast concrete producer for approval by the customer. These drawings shall show complete design, installation, and construction information in such detail as to enable the customer to determine the adequacy of the proposed units for the intended purpose. Details of steel reinforcement size and placement as well as supporting design calculations, if appropriate, shall be included. The precast concrete units shall be produced in accordance with the approved drawings.

Drawings Submitted by the Customer

The customer or customer's agent (specifier) may provide the precast concrete manufacturer with drawings for custom-made precast concrete units. Drawings shall be prepared and stamped by a licensed professional engineer. The customer or customer's agent may consult the precast concrete manufacturer during the design process on relevant production practices that may affect the design, production, handling and installation of the custom-made precast concrete unit. The customer or customer's agent accepts all liability associated with the use of the provided drawings.

1.3.3 Precast Concrete Unit Data

Standard Precast Concrete Units

For standard precast concrete units, the precast concrete producer shall supply cut sheets showing conformance to project drawings and requirements and to applicable industry design standards listed in this specification.

Proprietary Precast Concrete Units

For proprietary precast concrete units, the precast concrete producer shall supply standard plans or informative literature. Supporting calculations and design details shall be available upon request. The precast concrete producer shall provide sufficient information as to demonstrate that such products will perform the intended task.

Anchorage, Lifting Inserts and Devices

For anchors, lifting inserts and other devices, the precast concrete producer shall provide product data sheets and proper installation instructions upon request. The Precast concrete unit dimensions and safe working load shall be clearly indicated.

Accessory Items

For items including, but not limited to sealants, gaskets, pipe entry connectors, steps, racks and other items installed before or after delivery, the precast concrete producer shall include proper installation instructions and relevant product data upon request.

1.3.4 Design Data

Upon request, the precast concrete producer shall supply precast concrete unit design calculations and concrete mix design proportions and appropriate mix design test data. Structural design calculations shall be signed by a licensed professional engineer.

1.3.5 Test Reports

Upon request, the precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast-furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

Upon request, the precast concrete producer shall submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the project conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze-thaw durability, abrasion and absorption. Special tests for precast concrete items shall be clearly detailed in the specifications.

Upon request, the precast concrete producer will supply copies of in-plant QA/QC inspection reports.

1.3.6 Certificates

Submit quality control procedures established in accordance with NPCA Quality Control Manual for Precast Concrete Plants or verification of current NPCA Plant Certification.

1.4 DESIGN

1.4.1 Standard Precast Concrete Unit Design

Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards [ACI 318, ACI 350, ASTM, ACPA Design Manual, PCI MNL-120, and AASHTO]. Design must also consider stresses induced during handling, shipping and installation in order to avoid product cracking or other handling damage. Design loads for precast concrete units shall be indicated on the shop drawings.

1.4.2 Non-Standard Precast Concrete Unit Design

Design calculations and drawings of non-standard precast units shall be prepared and signed by a licensed professional engineer, and submitted for customer approval prior to fabrication. Calculations shall include the analysis of units for lifting stresses and the sizing of lifting devices.

1.4.3 Franchise Precast Concrete Units

Products manufactured under franchise arrangements shall conform to all the requirements specified by the franchiser. Items not included in the franchise specification but included in this specification shall conform to the requirements in this specification.

1.4.4 Joints and Sealants

Joints and sealants between adjacent units shall be of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

1.4.5 Concrete Mix Design

1.4.5.1 Concrete Proportions

Selection of proportions for concrete shall be based on the methodology presented in ACI 211.1 for normal weight concrete, ACI 211.2 for lightweight concrete and ACI 211.3 for no-slump concrete. The concrete proportions shall be developed using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Accelerators containing calcium chloride shall not be used in precast concrete containing reinforcing steel or other embedded metal items.

Upon request, the precast concrete producer shall submit a mix design for each strength and type of concrete that will be used. Submitted mix designs shall include the quantity, type, brand and applicable data sheets for all mix design constituents as well as documentation indicating conformance with applicable reference specifications.

The use of self-consolidating concrete is permitted provided that mix design proportions and constituents meet the requirements of this specification.

1.4.5.2 Durability and performance requirements

1.4.5.2.1 Concrete Compressive Strength

Precast concrete units shall have a 28-day compressive strength (f'c) of [] MPa, [] psi.

1.4.5.2.2 Water-Cement Ratio

Concrete that will be exposed to freezing and thawing shall contain entrained air (see 1.4.5.2.3) and shall have water-cement ratios of 0.45 or less. Concrete which will not be exposed to freezing, but which is required to be watertight, shall have a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. For corrosion protection, reinforced concrete exposed to deicer salts, brackish water or seawater shall have a water-cement ratio of 0.40 or less.

1.4.5.2.3 Air Content

The air content of concrete that will be exposed to freezing conditions shall be within the limits given below.

Nominal Maximum Aggregate Size (in)	Air Content %	
	Severe Exposure	Moderate Exposure
3/8	6.0 to 9.0	4.5 to 7.5
1/2	5.5 to 8.5	4.0 to 7.0
3/4	4.5 to 7.5	3.5 to 6.5
1	4.5 to 7.5	3.0 to 6.0
1-1/2	4.5 to 7.0	3.0 to 6.0
* For specified compressive strengths greater than 5000 psi, air content may be reduced 1%		

1.5 QUALITY ASSURANCE

Precast concrete producer shall demonstrate adherence to the standards set forth in the NPCA Quality Control Manual for Precast Concrete Plants. The precast concrete producer shall meet requirements written in subparagraph [1.5.1 or 1.5.2.]

NOTE: The use of subparagraph 1.5.1 may limit competition. Verify the availability of NPCA Certified precast concrete producers in the bidding area. Visit www.precast.org for a list of NPCA Certified precast concrete producers in your area.

1.5.1 NPCA Plant Certification

The precast concrete producer shall be certified by the NPCA Plant Certification Program prior to and during production of the products for this project.

1.5.2 Qualifications, Quality Control and Inspection

1.5.2.1 Qualifications

The precast concrete producer shall have been in the business of producing precast concrete units similar to those specified for a minimum of [] years. The precast concrete producer shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis. The agency shall issue a report, signed by a licensed professional engineer, detailing the ability of the precast concrete producer to produce quality units consistent with industry standards.

1.5.2.2 Quality Control

The precast concrete producer shall show that the following quality control tests are performed as required and in accordance with the ASTM International standards indicated.

- a. Slump: A slump test shall be performed for each 150 cu yd of concrete produced per mix design, or once a day, whichever comes first. Slump tests shall be performed in accordance with ASTM C 143. Slump flow tests on self-consolidating concrete mixes shall be performed in accordance with ASTM C 1611.
- b. Temperature: The temperature of fresh concrete shall be measured when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C 1064
- c. Compressive Strength: At least four compressive strength specimens shall be made for each 150 cubic yards of concrete of each mix design in accordance with the following applicable ASTM standards; C 31, C 39, C 192, C 497 [no-slump concrete].
- d. Air Content: Tests for air content shall be made on air-entrained, wet-cast concrete for each 150 cu yd of concrete, per mix design, but not less often than once each day when air-entrained concrete is used. The air content shall be determined in accordance with either ASTM C 231 or ASTM C 173 for normal weight aggregates and ASTM C 173 for lightweight aggregates.
- e. Density (Unit Weight): Tests for density shall be performed a minimum of once per week to verify the yield of batch mixes. Density tests shall be performed for each 100 cu yd of lightweight concrete in accordance with ASTM C 138. Density tests shall be performed for each 100 cu yd of concrete per mix design, but not less often than once per day when volumetric batch equipment is used.

NOTE: Producers utilizing self-consolidating concrete (SCC) shall conform to the quality control requirements established in the NPCA QC manual.

The precast concrete producer shall submit documentation demonstrating compliance with the above subparagraphs.

1.5.2.3 Inspection

The customer or customer's agent (specifier) may place an inspector in the plant when the units covered by this specification are being manufactured. The precast concrete producer shall give notice of [] days prior to the time the precast concrete units will be available for plant inspection.

1.6 HANDLING, STORAGE AND DELIVERY

1.6.1 Handling

Precast concrete units shall be handled and transported in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose as indicated on shop drawings. Upon request, the precast concrete producer shall provide documentation on acceptable handling methods for the product.

1.6.2 Storage

Precast concrete units shall be stored in a manner that will minimize potential damage.

1.6.3 Delivery

Precast concrete units shall be delivered to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite all precast concrete units shall be inspected by the customer or customer's agent for quality and final acceptance.

1.6.4 Final Acceptance

Upon final acceptance, the customer or customer's agent acknowledges and understands the appropriate methods for handling the accepted precast concrete unit(s). Upon acceptance by the customer or customer's agent, the precast concrete manufacturer is not responsible for replacing damaged product resulting from improper handling practices on the job site.

PART 2: PRECAST CONCRETE UNITS

2.1 MANUFACTURERS

The precast concrete manufacturer must meet the requirements established in section 1.5 Quality Assurance.

2.2 MATERIALS

Except as otherwise specified, material shall conform to the following section.

2.2.1 Cement

ASTM C 150 (Type I, II, III or V)

ASTM C 595 (for Blended Cements)

2.2.2 Silica Fume

ASTM C 1240

2.2.3 Fly Ash and Pozzolans

ASTM C 618

2.2.4 Ground Granulated Blast-Furnace Slag

ASTM C 989

2.2.5 Water

ASTM C1602

[The use of reclaimed/recycled process water shall be permitted.]

2.2.6 Aggregates

2.2.6.1 Aggregate Selection

NOTE: Select gradation(s) based on job requirements and constraints. The nominal maximum aggregate size should not exceed one-fifth the narrowest dimension between sides of forms, nor three-quarters the minimum clear spacing between individual reinforcing bars or wires.

Aggregates shall conform to ASTM C 33. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalis in the cement. Upon request, the precast concrete producer shall provide documentation indicating the aggregates are not susceptible to alkali-aggregate reaction.

2.2.6.2 Aggregates for Lightweight Concrete

ASTM C 330

2.2.7 Admixtures

2.2.7.1 Air-Entraining

ASTM C 260

NOTE: Air-entraining requirements may be deleted when the project is located in a nonfreezing climate or will not be exposed to freezing and thawing. However, certain product-specific ASTM Standards require the use of air-entrainment regardless of the climate.

2.2.7.2 Accelerating, Retarding, Water Reducing [Moderate to High]

ASTM C 494

2.2.7.3 Pigments

ASTM C 979

2.2.7.4 Corrosion Inhibitors

ASTM C 1582

NOTE: ASTM C 1582 corrosion inhibitors may be specified in lieu of epoxy-coated reinforcement when corrosion protection is required.

2.2.8 Reinforcement

2.2.8.1 Reinforcing Bars

NOTE: Specify ASTM A 706 reinforcing steel when welding or bending of reinforcement bars is critical. In addition, ASTM A 775 epoxy-coated reinforcing may be specified where extra reinforcement corrosion protection is required.

2.2.8.1.1 Deformed Billet-Steel

ASTM A 615

2.2.8.1.2 Deformed Low-Alloy Steel

ASTM A 706

2.2.8.2 Reinforcing Wire

2.2.8.2.1 Plain Wire

ASTM A 82

2.2.8.2.2 Deformed Wire

ASTM A 496

2.2.8.3 Welded Wire Reinforcement

2.2.8.3.1 Plain Wire

ASTM A 185

2.2.8.3.2 Deformed Wire

ASTM A 497

2.2.8.4 Epoxy Coated Reinforcement

2.2.8.4.1 Reinforcing Bars

ASTM A 775

2.2.8.4.2 Wires and Welded Wire Reinforcement

ASTM A 884

2.2.8.5 Galvanized Reinforcement

ASTM A 767

2.2.9 Inserts and Embedded Metal

All items embedded in concrete shall be of the type required for the intended use and meet the following standards.

2.2.9.1 Structural Steel Plates, Angles, etc.

ASTM A 36

2.2.9.2 Hot-Dipped Galvanized

ASTM A 152

2.2.9.3 Proprietary Items

In accordance with manufacturers published literature

2.2.10 Joint Sealants and Joint Gaskets

2.2.10.1 Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe

ASTM C 443

2.2.10.2 External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe

ASTM C 877

2.2.10.3 Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections

ASTM C 990

2.2.10.4 Elastomeric Joint Sealants

ASTM C 920

2.2.11 Pipe Entry Connectors

ASTM C 923

ASTM C 1478

2.2.12 Grout

2.2.12.1 Nonshrink Grout

ASTM C 1107

2.2.12.2 Cementitious Grout

Shall be of suitable mix design for the intended use, consisting of Portland cement, sand, and water. [Provide air entrainment for grout exposed to corrosive conditions or severe weather.]

NOTE: Air-entraining requirements may be deleted when the project is located in a nonfreezing climate or when freeze-thaw durability is not required.

2.3 MANUFACTURE

Manufacture shall conform to the NPCA Quality Control Manual for Precast Concrete Plants unless specified otherwise.

2.3.1 Forms

Forms for manufacturing precast concrete units shall be of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that the forces and vibrations to which the forms will be subjected cause no damage to the precast concrete unit.

Forms shall be cleaned of concrete build-up after each use.

Form release agents shall be applied according to the manufacturer's recommendations and shall not be allowed to build up on the form casting surfaces.

2.3.2 Reinforcement

Applicable ASTM International and/or ACI 318 standards for placement and splicing

Cages of reinforcement shall be fabricated either by tying the bars, wires or welded wire reinforcement into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4. Reinforcing shall be positioned as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 in. Concrete cover shall not be less than 1/2 in., unless otherwise specified. Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations.

2.3.3 Embedded Items

Embedded items shall be positioned at locations specified in the design documents. Welding shall be performed in accordance with AWS D1.1 when necessary. Inserts,

plates, weldments, lifting devices and other items to be embedded in precast concrete units shall be held rigidly in place so that they do not move significantly during casting operations.

2.3.4 Concrete

2.3.4.1 Concrete Mixing

Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

2.3.4.2 Concrete Placing

Conventional concrete shall be deposited into forms as near to its final location as practical. Self-consolidating concrete shall be placed in a manner in which it flows and consolidates without segregation or air entrapment. The free fall of the concrete shall be kept to a minimum. Concrete shall be consolidated in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Consolidation efforts are often not required when using self-consolidating concrete. Vibrators used to consolidate concrete shall have frequencies and amplitudes sufficient to produce well-consolidated concrete.

2.3.4.2.1 Cold Weather Concreting

Recommendations for cold weather concreting are given in detail ACI 306 R. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. All concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact shall be free from frost. Frozen materials or materials containing ice shall not be used. In cold weather the temperature of concrete at the time of placing shall not be below 45° F. Concrete that freezes before its compressive strength reaches 500 psi shall be discarded.

2.3.4.2.2 Hot Weather Concreting

Recommendations for hot weather concreting are given in ACI 305 R.

During hot weather, proper attention shall be given to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing shall not exceed 90° F.

2.3.4.3 Concrete Curing

Commence curing operations immediately following the initial set of the concrete and completion of surface finishing.

NOTE: Due to the immediacy of form removal, dry-cast products have a tendency to undergo undesirable accelerated drying. Consequently, early curing periods are most critical to ensure protection from extreme temperatures and dryness. Dry-cast products must be protected from drafts and wind to prevent plastic shrinkage cracking.

2.3.4.3.1 Curing by Moisture Retention

Moisture shall be prevented from evaporating from exposed surfaces until adequate strength for stripping the precast concrete unit from the forms is reached by one of the following methods:

- Cover with polyethylene sheets a minimum of 6 mils thick (ASTM C 171)
- Cover with burlap or other absorptive material and keep continually moist
- Use of a membrane-curing compound applied at a rate not to exceed 200 sq. ft. per gallon, or per manufacturers' recommendations (ASTM C 309)

[Surfaces that will be exposed to weather during service shall be cured as above a minimum of [] days. Forms shall be considered effective in preventing evaporation from the contact surfaces. If air temperature is below 50°F the curing period shall be extended.]

2.3.4.3.2 Curing with Heat and Moisture

Concrete shall not be subjected to steam or hot air until after the concrete has attained its initial set. Steam, if used, shall be applied within a suitable enclosure, which permits free circulation of the steam in accordance with ACI 517.2R. If hot air is used for curing, precautions shall be taken to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 150° F. These requirements do not apply to products cured with steam under pressure in an autoclave.

2.3.4.4 Surface Finish

Unformed surfaces of wet-cast precast concrete products shall be finished as specified. If no finishing procedure is specified, such surfaces shall be finished using a strike-off to level the concrete with the top of the form.

2.3.4.4.1 Formed Non-Architectural Surfaces

Surfaces shall be cast against approved forms in accordance with standard industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted. Major imperfections, excessive honeycombing or other major defects shall not be permitted.

2.3.4.4.2 Unformed Surfaces

Surfaces shall be finished with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted. Major imperfections, excessive honeycombing or other major defects shall not be permitted.

2.3.4.4.3 Special Finishes

Troweled, broom or other finishes shall be according to the requirements of project documents and performed per industry standards or supplier specifications.

Precast concrete producers shall submit sample finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

2.3.4.4.4 Architectural Finishes

Architectural finishes shall be according to the requirements of project documents and performed per industry standards or supplier specifications.

Precast concrete producers shall submit sample finishes for approval when required by the project documents. Full-size mockups are recommended for the approval of architectural finishes, because color variations and surface imperfections are not always apparent on small scale samples. The sample finishes shall be approved prior to the start of production.

2.3.4.5 Stripping Precast Concrete Units From Forms

Precast concrete units shall not be removed from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal. Stripping strengths shall be routinely measured to ensure product has attained sufficient strength for safe handling.

2.3.4.6 Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

2.3.4.6.1 Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete unit may be repaired by any method that does not impair the product.

2.3.4.6.2 Repairing Honeycombed Areas

When honeycombed areas are to be repaired, all loose material shall be removed and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. If a proprietary repair material is not used, the area shall be saturated with water. Immediately prior to repair, the area should be damp, but free of excess water. A cement-sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

2.3.4.6.3 Repairing Major Defects

Defects in precast concrete products which impair the functional use or the expected life of products shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

2.3.4.7 Shipping Precast Concrete Units

Precast concrete units shall not be shipped until they are at least [] days old, unless it can be shown that the concrete strength has reached at least 75% of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

PART 3: EXECUTION

3.1 INSTALLATION

3.1.1 Site Access

The general contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete units.

3.1.2 Installation

- Precast concrete units shall be installed to the lines and grades shown in the contract documents or otherwise specified.
- Precast concrete units shall be lifted by suitable lifting devices at points provided by the precast concrete producer.
- Precast concrete units shall be installed in accordance with applicable industry standards. Upon request, the precast concrete producer shall provide installation instructions.
- Field modifications to the product shall relieve the precast producer of liability regardless if such modifications result in the failure of the precast concrete unit.

3.1.3 Watertightness

Where watertightness is a necessary performance characteristic of the precast concrete unit's end use, watertight joints, pipe-entry connectors and inserts should be used to ensure the integrity of the entire system.

3.2 FIELD QUALITY CONTROL

3.2.1 Job Site tests

When watertightness testing is required for a precast concrete structure, one of the following methods may be followed:

3.2.1.2 Vacuum Testing

Prior to backfill, vacuum test system according to [ASTM C1244 (for manholes)]
[ASTM C 1227 (for septic tanks)]

NOTE: Manholes and septic tanks should be tested prior to backfilling to verify the integrity of the installed product. Testing prior to backfilling facilitates quick and easy repair when required.

When vacuum testing a backfilled manhole, appropriate adjustments must be made to the testing procedure to account for site conditions such as high water tables as to avoid over loading boots and connectors. Prior to vacuum testing, calculations shall be made to ensure that connectors and boots are not loaded past the design limit as indicated in ASTM C 923.

3.2.1.2 Hydrostatic Testing

According to contract documents and precast concrete producer's recommendations [or ASTM C 1227 (for septic tanks)].

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