

Guide Specification Precast Concrete Products

This specification should be used only by qualified professionals who are competent to evaluate the significance and limitations of the specification and who will accept responsibility for the application of its requirements to the products being considered.

1. GENERAL

o 1.1 Scope

This specification covers the materials for and manufacture of precast reinforced concrete units produced in accordance with the plans and these specifications.

o 1.2 Standards

Where applicable, the latest editions of the following standards shall be considered a part of these specifications. In case of conflict, these specifications shall take precedence over the listed standard. (See also Section 3, Materials)

■ 1.2.1 American Society for Testing and Materials (ASTM)

ASTM C478 "Specification for Precast Reinforced Concrete Manholes Sections"

ASTM C789 "Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers"

ASTM C825 "Specification for Precast Reinforced Concrete Barrier"

ASTM C850 "Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 ft Cover Subjected to Highway Loading"

ASTM C857 "Recommended Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures"

ASTM C858 "Specification for Underground Precast Concrete Utility Structures"

ASTM C890 "Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater"

Structures"

ASTM C913 "Specification for Precast Concrete Water and Wastewater Structures"

ASTM C915 "Specification for Precast Reinforced Concrete Crib Wall Members"

ASTM C923 "Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes"

ASTM C936 "Specification for Solid Concrete Interlocking Paving Units"

ASTM C990 "Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants"

ASTM C1227 "Specification for Precast Concrete Septic Tanks"

- **1.2.2 American Concrete Institute (ACI)**

ACI 318 "Building Code Requirements for Reinforced Concrete"

- **1.2.3 American Association of State Highway and Transportation Officials (AASHTO)**

- **1.2.4 American Welding Society (AWS)**

"Standard Specification for Highway Bridges"
Guide Specifications for Structural Design of Sound Barriers"

- **1.3 Franchise Products**

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.

2. PLAN REQUIREMENTS

- **2.1 Standard Units**

For standard units, the manufacturer of precast concrete products will supply cut sheets showing conformance to project drawings and requirements and applicable ASTM specifications listed in this specification. The manufacturer shall certify that such products will meet the ASTM specifications.

- **2.2 Custom-made Units**

The plans for precast concrete units shall be shop drawings furnished by the manufacturer for approval by the owner or his agent (specifier). These drawings

shall show complete design, installation, and construction information in such detail as to enable the owner to determine the adequacy of the proposed units for the intended purpose. Details of steel reinforcement size and placement and supporting design calculations, if appropriate, shall be included. The drawings shall include a schedule which will list the size and type of precast concrete unit at each location where the units are to be used. The precast concrete units shall be produced in accordance with the approved drawings.

○ 2.3 Proprietary Units

For proprietary units, the manufacturer of precast concrete products may supply standards plans or informative literature. Supporting calculations and design details shall be available upon request. The manufacturer shall warrant that such products will perform the intended task.

3. MATERIALS

○ 3.1 Concrete

Raw materials for concrete shall meet the following standards.

- **3.1.1 Portland Cement:** ASTM C150, Type I, II, III or V.

- **3.1.2 Aggregates:** ASTM C33 or C330.

- **3.1.3 Water:**

Portable or free of deleterious substances in amounts harmful to concrete or embedded metals.

- **3.1.4 Admixtures:**

1. Air-entraining: ASTM C260
2. Water reducing, retarding, accelerating, high range water reducing: ASTM C494
3. Pozzolans, fly ash and other mineral admixtures: ASTM C618
4. Ground granulated blast furnace slag: ASTM C989

○ 3.2 Reinforcing Steel

Concrete reinforcement shall be steel bars or welded wire fabric, or a combination. Reinforcement shall meet the following standards:

- **3.2.1 Bars:**

Deformed Billet-steel: ASTM A615
Deformed Rail-steel: ASTM A616
Deformed Axle-steel: ASTM A617
Deformed Low-alloy steel: ASTM A706

- **3.2.2 Wire:**

Plain: ASTM A82
Deformed: ASTM A496

■ **3.2.3 Welded Wire Fabric:**

Plain: ASTM A185
Deformed: ASTM A497

■ **3.2.4 Epoxy Coated Reinforcement:**

Reinforcing Bars: ASTM A775
Wire and Fabric: ASTM A884

■ **3.2.5 Galvanized Reinforcement:**

Reinforcing Bars: ASTM A767

○ **3.3 Inserts and Embedded Metal**

All items embedded in concrete shall be of the type required for the intended task, and meet the following standards:

■ **3.3.1 Structural steel plates, angles, etc:** ASTM A36

■ **3.3.2 Proprietary items:** In accordance with manufacturers published literature

■ **3.3.3 Welded stubs:** AWS D1.1

■ **3.3.4 Finishes (as required):**

1. Shop primer: Manufacturers' standards
2. Hot-dipped galvanized: ASTM A152
3. Zinc-rich coating: MIL-P-2135 self curing, one component, sacrificial
4. Cadmium coating

○ **3.4 Joint Sealant and Joint Gaskets:**

■ **3.4.1 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets:** ASTM C443

■ **3.4.2 External Sealing Bands for Noncircular Sewer and Culvert Pipe, Using Rubber Gaskets:** ASTM C877

■ **3.4.3 Joints for Concrete Pipe, Manholes, and Manufactured Box Sections Using Preformed Flexible Joint Sealants:** ASTM C990

■ **3.4.4 Specification for Elastomeric Joint Sealants:** ASTM C920

- **3.5 Pipe Entry Connectors:**

- **3.5.1 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals:** ASTM C923

- **3.6 Grout:**

- **3.6.1 Cement grout:** Portland cement with enough water for the required strength and sand for proper consistency. May contain mineral or chemical admixtures, if approved by owner's representative.
 - **3.6.2 Non-shrink grout:** Premixed, packages expansive and non-expansive shrink resistant grout.

4. CONCRETE MIXES

- **4.1 Mix Proportions**

Concrete shall be a uniform mix of quality materials listed in Section 3.1. Mix proportions shall be determined by following the standards in ACI 318 Chapter 5. (*1*)

- **4.2 Water-Cement Ratio and Air Content**

Concrete which will be exposed to freezing and thawing shall contain entrained air 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 0.50 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 sea water shall have a water-cement ratio of 0.40 or less.

The air content of concrete which will be exposed to freezing shall be within the limits given in Table 4.2.

Table 4.2 Total Air Content For Frost-Resistant Concrete

Nominal Maximum Aggregate Size, in.	Air Content, 0/0 *	
	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	4.0 to 7.0	3.0 to 6.0

*For specified compressive strengths greater than 5000 psi, air content may be reduced 1%.

- **4.3 Compressive Strength**

All concrete shall develop a minimum compressive strength of 4000 psi in 28 days unless other strengths are designed on the drawings.

5. MANUFACTURE

- **5.1 Forms**

Forms for manufacturing precast concrete products shall be of the type and design consistent with industry standards. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that no product damage shall be caused by the forces and vibrations to which the forms will be subjected. Forms shall be cleaned of concrete buildup after each use. Coating of form release agents shall not be allowed to build up.

- **5.2 Reinforcement**

Cages of reinforcement shall be fabricated either by tying the bars, wires or welded wire fabric 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 be less than 1/2 in. Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations.

- **5.3 Embedded Items**

Embedded items shall be positioned at location specified in the design documents. Inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products shall be held rigidly in place so that they do not move significantly during the casting operations.

- **5.4 Placing Concrete**

Concrete shall be deposited into forms as near to its' final location as practical. 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. Vibrators used to consolidate concrete shall have frequencies and amplitudes sufficient to produce well consolidated concrete.

- **5.5 Cold Weather Requirements (*2*)**

- **5.5.1** Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather.
- **5.5.2** All concrete materials and all reinforcement, forms, fillers, and ground with which

concrete is to come in contact shall be free from frost.

- **5.5.3** Frozen materials or materials containing ice shall not be used.

- **5.6 Hot Weather Requirements *3***

During hot weather, proper attention shall be given to ingredients, 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.

- **5.7 Curing**

- **5.7.1 Curing by Moisture Retention**

Moisture shall be prevented from evaporating from exposed surfaces until adequate strength for stripping (Section 5.7) is reached by one of the following methods:

1. Cover with polyethylene sheets a minimum of 6 mils thick.
2. Cover with burlap or other absorptive material and keep continually moist.
3. Curing compounds applied at a rate not to exceed 200 sq. ft. per gallon.

Surfaces which will be exposed to weather during service shall be cured as above a minimum of 3 days. Forms shall be considered effective in preventing evaporation from the contact surfaces. If air temperature is below 50 degrees F the curing period shall be extended.

- **5.7.2 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. 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 190 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

- **5.8 Finishes**

- **5.8.1 Standard formed surfaces:** Surfaces cast against approved forms using industry practice 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 tolerated but no major imperfections, honeycombs or other defects will be permitted.

- **5.8.2 Standard unformed surfaces:** Surfaces finished with a vibrating screen, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be tolerated but no major imperfections, honeycomb, or other defects shall be permitted.

- **5.8.3 Special finishes:**

- **5.8.3.1** Troweled, broomed or other finishes shall be according to the requirements of project documents and performed per industry standards or supplier specifications.
- **5.8.3.2** Manufacturers shall submit finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

- **5.9 Stripping Products from Forms**

Products 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.

- **5.10 Patching and Repairs**

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

- **5.10.1 Repairing Minor Defects**

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

- **5.10.2 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 plans 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 and, immediately prior to repair, the area should be damp, but there should not be 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.

- **5.10.3 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.

6. QUALITY ASSURANCE

Manufacturer of precast concrete products shall be a member of the National Precast Concrete Association (NPCA) and demonstrate adherence to the standards set forth in the *NPCA Quality Control Manual*. Manufacturer shall meet either Section 6.1 or 6.2.

○ 6.1 NPCA Certification

The manufacture of precast concrete products shall be certified by the National Precast Concrete Association's Plant Certification Program prior to and during production of the products for this project.

○ 6.2 Qualifications, Testing and Inspection

- 6.2.1 The manufacturer shall have been in the business of producing manufactured precast concrete products similar to those specified for a minimum of 5 years. He shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis. The agency shall issue a report, certified by a licensed engineer, detailing the ability of the manufacturer to produce quality products consistent with industry standards.
- 6.2.2 The manufacturer shall show that the following tests are performed in accordance with the ASTM standards indicated. Tests shall be performed for each 150 cu. yd. of concrete placed, but not less frequently than once per week.
 1. Slump: C143
 2. Compressive Strength: C31, C192, C39
 3. Air Content (when air-entrained concrete is being used): C231 or C173
 4. Unit Weight: C138
- 6.2.3 The manufacturer shall provide documentation demonstrating compliance with this section.
- 6.2.4 The owner may place an inspector in the plant when the products covered by this specification are being manufactured.

7. STORAGE AND SHIPMENT

○ 7.1 Handling

Products shall be stored, handled and shipped in a manner to minimize damage. Lifting holes or inserts shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for the purpose of handling.

○ 7.2 Minimum Strength

Products shall not be shipped until they are at least 5 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 be caused which will impair the performance of the products.

○ 7.3 Acceptance

Final inspection and acceptance of the manufactured precast concrete products shall be made by the owner's representative upon arrival at the jobsite.

8. INSTALLATION

- **8.1 Site Access**

General contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage and proper handling of the manufactured precast concrete products.

- **8.2 Installation**

Manufactured precast concrete products shall be installed to the lines and grades shown in the contract documents or otherwise specified. Products shall be lifted by suitable lifting devices at points provided by the manufacturer. Products shall be installed per the manufacturer's recommendation.

- **8.3 Watertightness**

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

- **8.3.1 Testing**

When testing is required for an underground product one of the following methods need to be followed:

1. Vacuum testing prior to backfill according to ASTM C1244.
2. Water testing according to contract documents and manufacturer's recommendations.

1 Recommendations for selecting proportions for concrete are given in detail in "*Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete*" (ACI 211.1). (Provides two methods for selecting and adjusting proportions for normal weight concrete: the estimated weight and absolute volume methods. Example calculations are shown for both methods. Proportioning of heavyweight concrete by the absolute volume method is presented in an appendix.)

Recommendations for lightweight concrete are given in "*Standard Practiced for Selecting Structural Lightweight Concrete*" (ACI 211.2). (Provides a method of proportioning and adjusting structural grade concrete containing lightweights aggregates.)

2 Recommendations for cold weather concreting are given in detail in "*Cold Weather Concreting*" reported by ACI Committee 306. (Presents requirements and methods for producing satisfactory concrete during cold weather.)

3 Recommendations for hot weather concreting are given in detail in "*Hot Weather Concreting*" reported by ACI Committee 305. (Defines the hot weather factors that affect concrete properties and construction practices and recommends measure to eliminate or minimize the undesirable effects.)

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