



## Standard Specification for Precast Concrete Septic Tanks<sup>1</sup>

This standard is issued under the fixed designation C 1227; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers design requirements manufacturing practices, and performance requirements for monolithic or sectional precast concrete septic tanks.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- A 82 Specification for Steel Wire, Plain, for Concrete Reinforcement<sup>2</sup>
- A 184/A 184M Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement<sup>2</sup>
- A 185 Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement<sup>2</sup>
- A 496 Specification for Steel Wire, Deformed, for Concrete Reinforcement<sup>2</sup>
- A 497 Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement<sup>2</sup>
- A 615/A 615M Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement<sup>2</sup>
- A 616/A 616M Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement<sup>2</sup>
- A 617/A 617M Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement<sup>2</sup>
- C 33 Specification for Concrete Aggregates<sup>3</sup>
- C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens<sup>3</sup>
- C 94 Specification for Ready-Mixed Concrete<sup>3</sup>
- C 125 Terminology Relating to Concrete and Concrete Aggregates<sup>3</sup>
- C 150 Specification for Portland Cement<sup>4</sup>
- C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method<sup>3</sup>
- C 260 Specification for Air-Entraining Admixtures for Concrete<sup>3</sup>

C 330 Specification for Lightweight Aggregates for Structural Concrete<sup>3</sup>

C 494 Specification for Chemical Admixtures for Concrete<sup>3</sup>

C 595M Specification for Blended Hydraulic Cements<sup>4</sup>

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete<sup>3</sup>

C 685 Specification for Concrete Made by Volumetric Batching and Continuous Mixing<sup>3</sup>

C 890 Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures<sup>5</sup>

#### 2.2 ACI Standard<sup>6</sup>

ACI 318-89 Building Code Requirements for Reinforced Concrete

### 3. Terminology

3.1 For definitions of terms relating to concrete, see Terminology C 125.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *access opening*—a hole in the top slab used to gain access to the inside of the tank for the purpose of cleaning and removing sludge without a person actually having to enter the tank.

3.2.2 *air scum volume*—the number of cubic inches (centimetres) in the space between the liquid surface and the underside of the top slab.

3.2.3 *inspection opening*—a hole in the top slab used for the purpose of observing conditions inside the tank.

3.2.4 *joint*—a physical separation where two pieces of precast concrete are in contact.

3.2.5 *non-sealed joint*—a joint where sealant is not used but where a machined fit will minimize the movement of liquid from one side of a precast concrete wall to the opposite side.

3.2.6 *sealed joint*—a joint that is sealed to prevent liquid passing from one side of a precast concrete wall to the opposite side.

3.2.7 *septic tank system*—an anaerobic digestion chamber in which domestic sewage is received and retained, and from which the liquid effluent, which is comparatively free from settleable and floating solids, is then discharged.

### 4. Ordering Information

4.1 The purchaser shall include the following information

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<sup>2</sup> Annual Book of ASTM Standards, Vol 01.04.

<sup>3</sup> Annual Book of ASTM Standards, Vol 04.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 04.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 04.05.

<sup>6</sup> American Concrete Institute (ACI), Box 19150, Redford Station, Detroit, MI 48219.

in bidding documents and on the purchase order, as may be applicable to the units being ordered:

- 4.1.1 Reference to this specification, and date of issue.
- 4.1.2 Quantity, that is, number of units ordered.
- 4.1.3 Capacity of tank in gallons or litres.
- 4.1.4 Whether or not, due to conditions of use, the concrete must be made with moderate sulfate-resisting cement, Specification C 150 Type II, or highly sulfate-resisting cement, Specification C 150, Type V. If the purchaser does not stipulate, the manufacturer shall use any cement meeting the requirements of Specification C 150 or C 595M.
- 4.1.5 Whether or not, acceptance will be based on a review of the calculations or on proof tests.
- 4.1.6 Design requirements such as depth of earth cover, live load applied at the surface, and ground water level.
- 4.1.7 Whether or not testing for leakage at the jobsite will be required.

## 5. Materials and Manufacture

5.1 *Cement*—Portland cement shall conform to the requirements of Specification C 150 or shall be portland blast-furnace slag cement or portland-pozzolan cement conforming to the requirements of Specification C 595M.

5.2 *Aggregates*—Aggregates shall conform to Specification C 33 and lightweight aggregates shall conform to Specification C 330, except that the requirements for grading shall not apply.

5.3 *Water*—Water used in mixing concrete shall be clean and free of injurious amounts of oils, acids, alkalies, salts, organic materials, or other substances that may be incompatible with concrete or steel.

5.4 *Admixtures*—Admixtures may be used provided such admixtures conform to Specification C 494 or C 618 and are not injurious to other products used in the concrete.

5.4.1 *Air-Entraining Admixtures*—Air-entraining admixtures conforming to Specification C 260 shall be used when there is a risk that the concrete may be exposed to freezing and thawing. Then the concrete mixture shall contain  $5.5 \pm 1.5$  % air by volume as determined by Test Method C 231.

5.5 *Steel Reinforcement*—Steel reinforcement shall conform to Specification A 82 or A 496 for wire; Specification A 185 or A 497 for wire fabric; or Specification A 184/A 184M, A 615/A 615M, A 616/A 616M, or A 617/A 617M for bars.

5.5.1 *Locating Reinforcement*—Reinforcement shall be placed in the forms as required by the design.

5.5.2 *Holding Reinforcement in Position During Pouring Placement*—Reinforcement must be securely tied in place to maintain position during concrete placing operations. Chairs, bolsters, braces, and spacers in contact with forms shall have a corrosion-resistant surface.

5.6 *Concrete Mixtures*—The aggregates, cement, and water shall be proportioned and mixed to produce a homogeneous concrete meeting the requirements of this specification, and in accordance with Specification C 94 or C 685.

5.7 *Forms*—The forms used in manufacture shall be sufficiently rigid and accurate to maintain the dimensions of the structure within the stated tolerances. All casting surfaces shall be of smooth nonporous material. Form releasing agents used shall not be injurious to the concrete.

5.8 *Concrete Placement*—Concrete shall be placed in the forms at a rate to allow the concrete to consolidate in all parts of the form, and around all reinforcement steel and embedded fixtures without segregation of materials.

5.9 *Curing*—The precast concrete sections may be cured by any method or combination of methods that will develop the specified compressive strength at 28 days or less.

5.10 *Concrete Quality*—The quality of the concrete shall be in accordance with the chapter on concrete quality in ACI 318, except for frequency of tests, which shall be specified by the purchaser. Concrete compressive strength tests shall be conducted in accordance with Test Method C 39.

## 6. Structural Design Requirements

6.1 Structural design of septic tanks shall be by calculation or by performance.

6.1.1 Design by calculation shall be completed using the Strength Design Method (ultimate strength theory) or the Alternate Design Method (working stress theory) outlined in ACI 318-89. The Strength Design Method is outlined in Chapter 9 and the Alternate Design Method is in Appendix A.

6.1.2 Design by performance requires the manufacturer to demonstrate that failure will not occur by physically applying loads to the product. The load applied shall be 1.5 times the anticipated actual loads.

6.1.3 Tanks shall be designed so that they will not collapse or rupture when subjected to anticipated earth and hydrostatic pressures when the tanks are either full or empty.

6.1.4 After conditions are established, loads from Practice C 890 shall be used for design. Unless heavier live loads are expected, the minimum live load at the surface for design shall be 300 lbf/ft<sup>2</sup> (14 kPa).

6.1.5 The live loads imposed at lifting points shall be considered in the design of the structure.

6.1.6 Inserts embedded in the concrete shall be designed for an ultimate load that is four times the working load (Factor of Safety = 4).

6.2 *Concrete Strength*—The minimum compressive strength (*f*'*c*) for designs shall be 4000 psi (28 MPa) at 28 days of age.

6.3 *Reinforcing Steel Placement*—The concrete cover for reinforcing bars, mats, or fabric shall not be less than 1 in. (25 mm).

6.4 *Openings*—The structural design shall take into consideration the number, placement, and size of all openings.

6.5 Lift equipment shall be designed for an ultimate load that is five times the working load (Factor of Safety = 5).

## 7. Physical Design Requirements

7.1 *Capacity*—Sizes are generally specified by local regulations and they shall supersede the following guidelines. When local regulations are not available, the following minimum sizes will be required:

1-bedroom residence	750 gal (2800 L)
2 and 3-bedroom residence	1000 gal (3800 L)
4-bedroom residence	1200 gal (4500 L)
5-bedroom residence	1400 gal (5300 L)
Motels	100 gpd/unit (380 Lpd/unit)
Restaurant	70 gpd/seat (265 Lpd/seat)
Office Building	20 gpd/seat (75 Lpd/seat)
Additional capacity is required when grinders are available	

7.2 *Shape:*

7.2.1 There shall be no less than 25 ft<sup>2</sup> (2.3 m<sup>2</sup>) of surface liquid area and at least 6 ft (2 m) between inlet and outlets.

7.2.2 The air scum volume above the liquid shall be at least 12½ % of the volume of liquid but not less than 9 in. (230 mm) high for entire surface above liquid.

7.2.3 Minimum water depth shall be 36 in. (900 mm) unless otherwise approved by local code or jurisdiction.

7.2.4 Maximum liquid depth shall be 72 in. (1800 mm) unless otherwise approved or required by local codes or jurisdiction.

7.3 *Compartments:*

7.3.1 The septic tank system shall include two compartments unless otherwise approved by local codes or jurisdiction.

7.3.2 One double unit or two single compartment units in series are acceptable.

7.3.3 The first compartment shall have a liquid volume of approximately two thirds of the liquid volume of the entire contents of the system.

7.3.4 The transfer port between compartments shall be sized to maintain a low velocity as liquid moves between compartments. A minimum of 50 in.<sup>2</sup> (320 cm<sup>2</sup>) is recommended where local codes do not specify otherwise.

7.3.5 The transfer port shall be in the middle 25 % of the distance from the bottom of the tank to the water line.

7.3.6 No baffle, tee, outlet filter unit, or compartment wall shall extend to the interior roof without providing for venting. The cross-sectional area of a vent shall be at least equivalent to a 4-in. (100-mm) diameter pipe.

7.4 *Influent and Effluent Pipes:*

7.4.1 The influent pipe shall be no less than 4 in. (100 mm) in diameter.

7.4.2 The difference between the invert of the influent pipe and the invert of the effluent pipe shall be a minimum of 2 in. (50 mm) and a maximum of 4 in. (100 mm).

7.4.3 Inlet and outlet pipes shall be connected to the tank with a sealed flexible joint to accommodate tank movement.

7.5 *Baffles and Outlet Devices:*

7.5.1 A baffles or tee shall be placed at the influent pipe. An outlet baffle or tee equipped with a solid deflection device or an outlet filter device shall be placed at the effluent pipe.

7.5.2 Baffles or tees can be made monolithically with the tank. Baffles, tees, and outlet devices shall be made of noncorrosive materials and shall be permanently connected with noncorrosive fasteners or fittings to the inside of the tank or inlet/outlet piping.

7.5.3 Inlet baffles or tees shall extend at least 8 in. (200 mm) below the water line and at least 5 in. (125 mm) above the water line.

7.5.4 The outlet device shall extend below the water line at least 10 in. (250 mm) but no lower than 40 % of the tank total liquid depth. It shall extend 5 in. (125 mm) above liquid level.

7.5.5 Outlet filter device shall be maintained in accordance with manufacturer's recommendations or requirements of regulating agencies, or both.

7.5.6 A gas deflector shall be placed for the purpose of deflecting suspended solids away from the outlet. It shall be placed below the outlet tee or baffle with an angle to the bottom slab of 60° (1 rad). It shall be placed below the

entrance of liquid to the effluent pipe a maximum of 6 in. (150 mm) measured at front of the deflector. The deflector shall extend 2 in. (50 mm) beyond the entrance on all sides.

7.5.7 Specifications for baffles, tees, and outlet devices are for normal, low-flow conditions. High-flow conditions, created when liquid is pumped from another tank, may require other dimensions and considerations. Design by a qualified engineer is recommended.

7.6 *Openings in Top Slab:*

7.6.1 An access opening shall be located over the influent baffle and the effluent baffle. Where an opening has any dimension greater than 12 in. (300 mm) the lid shall weigh a minimum of 59 lb (27 kg) or be provided with a lock system to prevent unauthorized entrance.

7.6.2 An access opening or openings shall be provided to permit pumping of all compartments.

7.6.3 An inspection hole, at least 4 in. (100 mm) in diameter, shall be located over an interior divider in a two-compartment tank.

7.6.4 Handles shall be provided when the top of a cover is flush with the top of the top slab. Handles shall be made of plastic- or epoxy-coated steel bar.

7.6.5 Handles are not required when the cover sits on top of the slab. The cover must be prevented from moving laterally if sitting on top of the slab.

7.6.6 Where covers are flush with or above ground they shall be provided with a lock system to prevent unauthorized entrance.

7.6.7 If cover is below grade it shall have a minimum of 6 in. (150 mm) and a maximum of 12 in. (300 mm) of earth above.

7.6.8 If top slab is more than 12 in. (300 mm) below grade, risers will be required to make the top of the cover meet the requirements of 7.6.7.

8. **Quality Control and Sampling**

8.1 The manufacturer shall have a quality control program and certify that the product meets three criteria: (1) water tightness (if properly installed), (2) physical dimensions, and (3) strength of structure.

8.2 When the customer specifies in the bidding documents and the purchase order, the manufacturer shall select at random 1 of every 20 septic tanks to determine compliance with the provisions of this specification.

9. **Performance Test Methods**

9.1 Proof testing is used to demonstrate the strength of the tank to resist anticipated external and internal loads.

9.1.1 Proof testing, when required by the purchaser, shall be performed in such a way as to simulate the actual anticipated loads.

9.2 Testing for leakage, to determine leakage below water, is performed using either vacuum testing or water-pressure testing.

9.2.1 *Vacuum Testing*—Seal the empty tank and apply a vacuum to 2 in. (50 mm) of mercury. The tank is approved if 90 % of vacuum is held for 2 min.

9.2.2 *Water-Pressure Testing*—Seal the tank, fill with water, and let stand for 24 h. Refill the tank. The tank is approved if water level is held for 1 h.

## 10. Dimensions and Permissible Variations

10.1 *Dimensional Tolerances*—The length, width, height, or diameter measurements of the structure when measured on the inside surface shall not deviate from the design dimensions more than the following:

Dimension	Tolerance
0 to 5 ft (0 to 1.5 m)	±¼ in. (±6 mm)
5 to 10 ft (1.5 to 3.0 m)	±¾ in. (±10 mm)
10 to 20 ft (3.0 to 6.1 m)	±½ in. (±13 mm)
20 ft (6.1 m) and over	as agreed upon between the manufacturer and the purchaser

10.2 *Squareness Tolerance*—The inside of the rectangular precast concrete component shall be square as determined by diagonal measurements. The difference between such measurements shall not exceed:

Measured Length	Allowance Difference
0 to 10 ft (0 to 3.0 m)	½ in. (13 mm)
10 to 20 ft (3.0 to 6.1 m)	¾ in. (19 mm)
20 ft (6.1 m) and over	as agreed upon between the manufacturer and the purchaser

10.3 *Joint Surfaces*—The following joint tolerances for water-retaining structures shall apply:

10.3.1 *Flexible Joint*—The inside joint seam gap, between two sections placed together before a joint sealant is applied, shall not exceed ⅜ in. (10 mm).

10.3.2 *Grout Joint*—The opening to be grouted in a grout joint shall not exceed 1 in. (25 mm).

10.4 *Reinforcement Location*—With reference to thickness of wall or slab, reinforcement shall be within ±¼ in. (6 mm) of the design location, but in no case shall the cover be less than 1 in. (25 mm). The variation in reinforcement spacing shall not be more than one tenth of the designed bar spacing nor exceed 1½ in. (38 mm). The total number of bars shall not be less than that computed using the design spacing.

## 11. Repairs

11.1 Precast concrete structures may be repaired. Repairs shall be performed by the manufacturer in a manner that ensures that the repaired structure will conform to the requirements of this specification.

## 12. Rejection

12.1 Precast concrete structures or sections of structures shall be subject to rejection because of failure to conform to any of the requirements contained in this specification.

## 13. Product Marking

13.1 Each riser section shall be clearly marked by indentation or other approved means with (1) date of manufacture and (2) name or trademark of the manufacturer.

13.2 Each septic tank shall be clearly marked by indentation, or other approved means with (1) date of manufacture, (2) name or trademark of the manufacturer, and (3) indication of external loads for which the septic tank is designed to resist, including the number of feet of earth cover above top slab and surface load from Practice C 890, that is, A-03, A-8, A-12, or A-16, unless required otherwise by local codes.

13.2.1 When all the requirements of this specification are met, the product should be so stamped.

13.3 Where an access opening or an inspection opening has a dimension greater than 8 in. (200 mm) a label of noncorrosive material shall be placed in a prominent place to warn everyone that "Entrance into the tank could be fatal."

## 14. Keywords

14.1 anaerobic digestion; sanitary waste; septic tank; sewer; sewer treatment

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