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Standard Specification for Precast Concrete Septic Tanks[1]

This standard is issued under the fixed designation C1227; 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 (ε) 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 inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A1064/A1064M Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

A996/A996M Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

C33/C33M Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C94/C94M Specification for Ready-Mixed Concrete

C125 Terminology Relating to Concrete and Concrete Aggregates

C150/C150M Specification for Portland Cement

C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

C260/C260M Specification for Air-Entraining Admixtures for Concrete

C330/C330M Specification for Lightweight Aggregates for Structural Concrete

C494/C494M Specification for Chemical Admixtures for Concrete

C595/C595M Specification for Blended Hydraulic Cements

C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C685/C685M Specification for Concrete Made by Volumetric Batching and Continuous Mixing

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

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

C1116/C1116M Specification for Fiber-Reinforced Concrete

C1644 Specification for Resilient Connectors Between Reinforced Concrete On-Site Wastewater Tanks and Pipes

2.2 *ACI Standard:*[3]

ACI 318 Building Code Requirements for Reinforced Concrete

2.3 *NSF/ANSI Standard:*[4]

NSF/ANSI 46–2005 Evaluation of Components and Devices used in Wastewater Treatment Systems

3. Terminology

3.1 For definitions of terms relating to concrete, see Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

[1] This specification is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.30 on Water and Wastewater Containers.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.2.1 *access opening, n*—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, n*—number of cubic inches (centimeters) in the space between the liquid surface and the underside of the top slab.

3.2.3 *baffle, n*—device placed in a tank to dissipate energy, direct flow, retain solids, and/or draw liquid off at a specific depth.

3.2.4 *baffle, inlet, n*—tee or wall segment at or near the inlet pipe of a tank designed to direct flow below the liquid surface.

3.2.5 *baffle, outlet, n*—tee or wall segment at or near the outlet pipe of a tank designed to collect flow from the liquid effluent layer.

3.2.6 *cement, n*—powdered substance of lime and clay mixed with water to make concrete.

3.2.7 *connector, n*—device that provides a flexible seal between a pipe and the precast concrete tank.

3.2.8 *corrosion-resistant, adj*—materials that are resistant to deterioration when in contact with the corrosive materials found in a septic tank.

3.2.9 *dead load, n*—mass of a structure and all permanent loads imposed on the structure (that is, soil).

3.2.10 *detention time, n*—average length of time a unit volume of liquid or a suspended particle remains in a tank; mathematically, it is the volume of liquid in the tank divided by the flow rate through the tank.

3.2.11 *effective volume, n*—maximum amount of liquid and solids that can be contained in a tank under normal operating conditions.

3.2.12 *effluent filter device, n*—device, made from corrosion-resistant materials, that separates solid material from tank liquid before the liquid exits the tank.

3.2.13 *grinder, n*—device for grinding and flushing cooking wastes; also known as a garbage disposal.

3.2.14 *inspection opening, n*—hole in the top slab used for the purpose of observing conditions inside the tank.

3.2.15 *joint, n*—physical separation where two pieces of precast concrete are in contact.

3.2.16 *liquid effluent layer, n*—area in a tank made up of liquids and semibuoyant waste particles after the sludge and scum waste have separated and settled.

3.2.17 *live load, n*—loads exerted on or above a structure when the source of the load is dynamic and transient.

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

3.2.19 *owner, n*—is by definition, end user, customer, or purchaser.

3.2.20 *rated volume, n*—depth from the bottom of a septic tank to the invert of the outlet pipe.

3.2.21 *scum layer, n*—buoyant waste floating near the surface of liquid, consisting of lighter-than-water materials, such as greases and soaps.

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

3.2.23 *septic tank system, n*—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.

3.2.24 *sludge layer, n*—heavier waste solids that separate and settle at the bottom of a tank.

3.2.25 *tee, n*—"T"-shaped pipe fitting made of corrosion-resistant materials used to connect horizontal piping with vertical piping and used to provide access for cleaning piping.

4. Ordering Information

4.1 The purchaser shall include the following information in bidding documents and on the purchase order, as 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 liters.

4.1.4 Special cement requirements including moderate sulfate-resisting cement, Specification C150/C150M Type II, or highly sulfate-resisting cement, Specification C150/C150M, Type V. If the purchaser does not stipulate, the manufacturer shall use any cement meeting the requirements of Specification C150/C150M or C595/C595M.

4.1.5 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 Testing for water leakage shall not be required at the job site unless specifically required by the purchaser.

4.1.8 Manufacturer is permitted to require testing on site prior to backfill.

5. Materials and Manufacture

5.1 *Cement*—Portland cement shall conform to the requirements of Specification C150/C150M or shall be portland blast-furnace slag cement or portland-pozzolan cement conforming to the requirements of Specification C595/C595M.

5.2 *Aggregates*—Aggregates shall conform to Specification C33/C33M and lightweight aggregates shall conform to Specification C330/C330M, 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 will be incompatible with concrete or steel.

5.4 *Admixtures*—Admixtures, when used, shall conform to Specification C494/C494M or Specification C618 and shall not be injurious to other products used in the concrete.

5.4.1 *Air-Entraining Admixtures*—Air-entraining admixtures conforming to Specification C260/C260M shall be used

when there is a risk that the concrete will be exposed to freezing and thawing. Then the concrete mixture shall contain 5.5 ± 1.5 % air by volume as determined by Test Method C231/C231M.

5.5 *Steel Reinforcement*—Steel reinforcement shall conform to Specification A1064/A1064M for wire fabric, or Specifications A615/A615M, A706/A706M, or A996/A996M for steel reinforcement 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 shall be securely held in place by tying, clipping, or welding to maintain position during concrete placing operations. Welding procedures shall conform to the appropriate material specification. 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 C94/C94M or Specification C685/C685M. The concrete shall have a maximum water cementitious materials ratio of 0.45.

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 shall 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 C39/C39M.

5.11 *Fibers*—Polypropylene, polyolefin, or glass fibers are only permitted as a secondary reinforcing material, at the manufacturer's option, in precast concrete septic tanks. For the purposes of this specification, secondary reinforcing material is only used to resist temperature and shrinkage effects. Only Type II or III conforming to the requirements of Specification C1116/C1116M shall be accepted.

5.12 *Sealants*—Flexible sealants used in the manufacture and installation of tanks shall conform to Specification C990. Rigid (mortar) sealing of tank sections is not permitted.

5.13 *Pipe Connections*—Pipe-to-tank connections shall use flexible connectors conforming to the requirements of Specification C1644.

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. 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 The structural design of tanks will consider buoyancy effects, if applicable, and proportion the structure to ensure an adequate flotation safety factor.

6.1.5 All dead and live loads shall be considered in the design. For tanks located in residential lawn areas and not subject to loads greater than the minimum stated herein, the minimum live load shall be 100 lbf/ft^2 (5 kPa) or a concentrated load of 2250 lbs (10 kN) applied to a 10 by 10 in. (250 by 250 mm) area, which ever produces the greatest stress on the structure. Concentrated loads shall be distributed in accordance with provisions of Practice C890. Loading conditions other than described herein shall conform with provision of Practice C890.

6.1.6 After conditions are established, loads from Practice C890 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^2 (14 kPa).

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

6.1.8 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 a total of no less than 25 ft^2 (2.3 m^2) of surface liquid area and a total inside length of at least 6 ft (2 m) between inlet and outlet of the tank.

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. The two-compartment dividing wall is to be monolithically cast or placed secondarily utilizing a non-sealed joint with the tank body.

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 $in.^2$ (320 cm^2) shall be used 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 connector conforming to Specification C1644 to accommodate tank movement.

7.5 *Baffles and Outlet Devices:*

7.5.1 Baffles or tees shall be placed at the influent pipe. Outlet filter devices shall be placed at the effluent pipe.

7.5.2 Baffles or tees are permitted to be precast monolithically with the tank. If baffles, tees, or outlet filters are added, they shall be made of noncorrosive materials and be permanently connected with noncorrosive fasteners to either the inside of the tank or the outlet pipe.

7.5.3 The inlet baffle or tee shall extend at least 8 in. (200 mm) below the liquid level and at least 5 in. (125 mm) above the liquid level.

7.5.4 The outlet filter shall extend below the liquid line at least 10 in. (250 mm) but not more than 40 % of the depth of the liquid. It shall extend a minimum of 5 in. (125 mm) above the liquid level line. The filter device shall be constructed to prevent the discharge of floating solids in the event the liquid level in the tank overflows the top of the filter with the filter element in place. All filter devices must meet the performance criteria of NSF/ANSI Standard 46–2005 or most current revision.

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 Outlet filter devices shall be sized upon the estimated daily water use and the rated capacity of the filter per the manufacturer's specifications.

7.5.7 Specifications for baffles, tees, and outlet filter devices are for normal, low-flow conditions. High-flow conditions, created when liquid is pumped from another tank, will require consideration for other dimensions. Design by a qualified engineer is required for these cases.

7.5.8 Outlet solids deflectors may be used in conjunction with outlet filter devices to deflect suspended solids away from the outlet filter device and shall be installed per the manufacturer's instructions.

7.6 *Openings in Top Slab:*

7.6.1 An access opening shall be located over the influent pipe and the effluent pipe. 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 corrosion-resistant material and be capable of supporting the weight of the cover.

7.6.5 Handles are not required when the cover sits on top of the slab. The cover shall 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.