Watertightness of Precast Concrete Wastewater Structures

NOWRA Onsite Mega-Conference

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Watertightness

• Watertight: constructed to be impervious to water
5 Rules of Watertightness

1. Use a low w/c mix design
2. Meet the minimums for cementitious material content
3. Use well-graded aggregates
4. Follow quality manufacturing processes
5. Execute joints and penetrations carefully
1. Use a Low Water to Cement Ratio Mix Design

- In the right quantities, water and cement will create a very strong, dense durable, and impermeable paste
- The $w/c$ or $w/c_m$ should be as low as reasonably possible: 0.48 or lower
Water to Cement Ratios

• Water to cement ratio (w/c): weight of water / weight of cement in the batch
  • 288 lbs water / 600 lbs cement = 0.48

• Water to cementitious materials ratio (w/cm): weight of water / weight of all the cementitious materials in the batch
  • 288 lbs water / (60 lbs fly ash + 540 lbs cement) = 0.48
Finding a Balance

• Too much water:
  • Lower strength
  • Decreased durability
  • Less likelihood for watertightness

• Too little water:
  • Placement difficulties
  • Not enough water for all the cement to react
  • Surface imperfections
Watertightness

• Watertight: constructed to be impervious to water
2. Meet the Minimum Cement Content

• Minimum cement content of 564 lbs per cubic yard is recommended
• Finer cements can help reduce bleeding, but also may reduce fresh concrete workability
• Consider supplementary cementitious materials (SCMs)
3. Use Well-Graded Aggregates

- Aggregate gradation: the size distribution of the aggregates within a certain sample
4. Follow Quality Manufacturing Processes

Download or print the manual from precast.org
For Extra Protection

• Coatings:
  • Typically associated with protecting the concrete from something

• Sealants:
  • Designed to prevent infiltration and exfiltration
  • Applied to the concrete to surface
  • Some penetrate the surface and closes up any capillaries so it won’t peel off
For Extra Protection

• Damp proofing vs. water proofing:
  • Damp proofing: exterior coating, intended to keep soil moisture out, restricts the passage of water in the absence of hydrostatic pressure
  • Water proofing: prevents water infiltration/exfiltration when water is under pressure
  • Differences: physical properties of the materials, application thicknesses
For Extra Protection

• Joint wrap:
  • Applied to exterior surface

• Densifying or waterproofing admixtures
  • Liquid crystalline admixtures added during the fresh concrete mixing process, reacts with calcium hydroxide almost like pozzolans
  • Helps densify the concrete making it more difficult for water to penetrate
ASTM C1227

Designation: C1227 – 12

Standard Specification for Precast Concrete Septic Tanks

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 reaffirmation. A superscript epsilon (ε) indicates an editorial change since the last revision or reaffirmation.

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

C94/C94M Specification for Ready-Mixed Concrete
C125 Terminology Relating to Concrete and Concrete Aggregates
C150 Specification for Portland Cement
C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C260 Specification for Air-Entraining Admixtures for Concrete
C330 Specification for Lightweight Aggregates for Structural Concrete
C494/C494M Specification for Chemical Admixtures for Concrete
C595 Specification for Blended Hydraulic Cements
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
Vacuum Testing – ASTM C1227
Hydrostatic Test – ASTM C1227
5. Execute Joints and Penetrations Carefully

- Riser and Access
- Horizontal joint
- Pipe Connections
- Concrete itself
Risers and Access Points

- Riser and Access
- Horizontal joint
- Pipe Connections
- Concrete itself
Risers
Risers

- The lower section of the riser assembly should be:
  - Cast into the tank lid, or
  - Sealed to the top of the tank with butyl sealant conforming to ASTM C990
Horizontal Joints

- Riser and Access
- Horizontal joint
- Pipe Connections
- Concrete itself
Horizontal Joints

3/8” maximum gap between two mating joint surfaces BEFORE sealant is applied.

Must conform to ASTM C990.
Improper Sealant Placement
Improper Sealant Placement
Proper Sealant Placement
Proper Sealant Placement
Joint Sealants
What Makes Precast Concrete Structures Watertight?
Pipe Connections

- Riser and Access
- Horizontal joint
- Pipe Connections
- Concrete itself
Pipe to Tank Connections

- Prevent infiltration and exfiltration
  - Provide a permanent, flexible connection between pipe and tank
  - Provide for angular deflection of pipe
  - Provide for shear deflection of pipe
  - Provide sure, simple connection for installer
Uneven Base vs. Level Base
What Do We Look For?

• Appearance of tank
• Markings
• Capacity / Sizing / Compartments / Baffles
• Joint condition
• Connectors
• Risers
• On site testing
• Bedding
• Condition prior to backfilling practices
• Backfilling practices
Summary

1. Use a low w/c mix design
2. Meet minimums for cementitious material
3. Use well-graded aggregates
4. Follow quality manufacturing processes
5. Execute joints and penetrations carefully
Additional Resources

• NPCA website: [www.precast.org](http://www.precast.org)
  • NPCA QC Manual
  • Manual for Jointed Precast Concrete Pavement
  • Product-Specific Best Practices Manuals
  • Product-Specific White Papers
  • Specifier Webinars

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