Best Practices for

Connecting Multiple Precast Tanks

NPCA

National Precast Concrete Association

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DISCLAIMER
This manual does not claim or imply that it addresses all safety-related issues, if any, associated with its use. Installation of precast concrete products may involve the use of hazardous materials, operations and equipment. It is the user's responsibility to determine appropriate safety, health and environmental practices and applicable regulatory requirements associated with the use of this manual and the installation of precast concrete products.

Use of this manual does not guarantee the proper function or performance of any product designed or installed in accordance with the requirements contained in the manual. Routine conformance to the requirements of this manual should result in products of an acceptable quality according to current industry standards.

This document is subject to revision at any time by the NPCA Wastewater Treatment Products Committee, which must review it periodically.

Introduction

Water, stormwater, wastewater treatment and other utility applications consisting of multiple precast concrete tanks placed in close proximity have become a common occurrence. This can introduce some challenges for the contractor when it comes to backfill, connection of pipes and other factors.

This document's purpose is to highlight the specific issues and application unique to multiple precast tank applications. It provides guidance on material selection, manufacturing techniques, site layout, testing and installation and related component recommendations to attain a structurally sound, watertight, and durable precast concrete multiple precast tank Installation.

This document is intended to be a supplement to the NPCA resource, "Best Practices Manual - On-Site Wastewater Systems," available at precast.org. It is not intended for use as a regulatory code or minimum design standard, but rather as an aid to manufacturers, engineers, designers, contractors and owners. This document will be most effective when used in conjunction with a complete review of local codes and design considerations before designing, manufacturing or installing any multiple precast tank system. It is also important to follow tank manufacturers' instructions and recommendations on installing and connecting multiple tanks.

1. Impacts of Multiple Tank Configuration

When placing multiple concrete tanks in proximity, the layout can consist of tanks in series or parallel. This will usually depend on the application and site limitations. Tanks can be installed where walls adjoin or there is a space in between. There are a few reasons for this.

- **Lifting Considerations** – Closely spaced structures can present challenges when it comes to disengaging and removing lifting equipment from lift points.
- **Pipe Connections** – Tanks are usually connected by pipes of various types and diameters. Installation and maintenance of pipes, pipe connectors, gaskets and seals will be challenging if adjacent tank spacing is not considered.
- **Proper backfill** – Backfill around underground tanks can have a substantial impact on their durability and service life. Tanks in close proximity can lead to improper backfilling. This can cause stresses that can exceed the structure wall's design strength and cause cracking.

Let's look at each of these 3 important factors in detail.

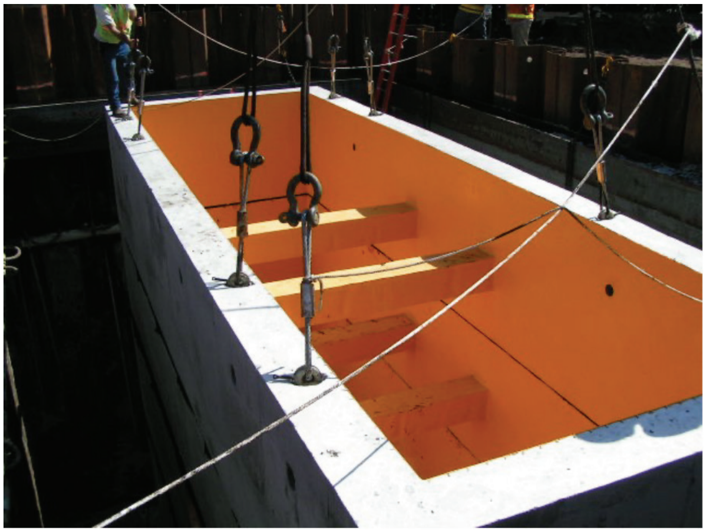


Figure 1: Examples of different tank lifting designs.

2. Lifting Considerations

In addition to meeting applicable lifting standards, the design engineer and manufacturer must designate lifting insert types and locations allowing for adequate clearances for safe structure installation and subsequent removal of lifting devices.

Tanks can be lifted in a variety of ways, including from the outside of the walls, the top of the walls and from the inside base of tank.

Devices or lifting points will be installed during tank manufacturing. The equipment used to lift the tanks (spreader bars, chains, hooks, clutches) must attach to those designated lift points and be disengaged once the tank is installed. If those lift points are on the outside of the tank, close spacing between adjacent structures can make it very challenging and even hazardous to disengage and remove the lifting equipment.

When the design allows, placing lifting inserts or other accessories inside or in the top of the tanks can help avoid issues with tight clearances.

Figure 2: Example of close proximity equalization tanks with pipe connection

3. Pipe Connections

The connection between the pipe and the precast structure is extremely important. That's why it is essential to select the right types of connectors. Robust, reliable connectors are critical components for liquid, water and wastewater storage and treatment structures. Not only do connectors help create continuous watertight seals that support a system's proper function, they also protect the surrounding soil and groundwater. The designer must first determine the performance requirements of the connection. Then, the designer must consider the multiple tank configuration and resulting installation and maintenance access to specify the appropriate connector.

3.1 Pipe Connector Specification and Location

If distances between tanks are insufficient, it makes it difficult to install, secure and maintain connecting piping and pipe connections. Types of pipe connectors (also called gaskets or seals) should be specified based on access. Tanks that are close together could benefit from connectors that can be tightened and maintained from the inside of the tank. If pipe connectors are to be installed, tightened or maintained from the outside of the structure, it is recommended that designers allow a minimum 36 inches of space between tanks to allow for proper access.

If space between tanks is making it difficult to tighten connectors around pipe, some connectors may be able to be installed backwards inverted so the band or bolts can be tightened from the inside of the tank. Check with the connector manufacturer to verify whether the connector can be installed in this manner.

3.2 Type of Pipe Connections

Pipe to precast structure connectors can be single component flexible connectors or modular compression seal type connectors.

Figure 3 : Examples of resilient flexible pipe connectors

3.2.1 Resilient flexible connectors

Resilient flexible connectors are often used because of their ability to keep the connection watertight and also allow some differential pipe to structure movement without losing its integrity. They can be cast into the precast product during manufacturing or installed post manufacturing.

Two main ASTM standards exist for resilient flexible connectors:

ASTM C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

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

ASTM C923 compliant connectors are used for deeper buried connections with hydrostatic pressures up to 13 psi (30 ft) [90 kPa (9.1 m)] in straight alignment, up to 10 psi (23 ft [69 kPa (7.0 m)] axially defected at least 7 degrees in any direction, and up to 10 psi when shear loaded.

ASTM C1644 compliant connectors are designed for more shallow depths with hydrostatic pressures up to 5 psi (11.5 ft [34.5 kPa (3.5 m)] in straight alignment, up to 5 psi axially defected at least 7 degrees in any direction, and up to 5 psi when shear loaded.

All connectors should be installed as per manufacturer instructions.

3.2.2 Modular Connectors

These types of connectors are rigid and designed for larger pressure applications or specific site or design connections. **(Advertised capacity of 20+ psi)**

They can be installed in the field in a cored or cast hole and in a wall sleeve.

Figure 4 : Modular pipe connectors

3.3 Connector Material

3.3.1 Chemical Resistance – Most connecters are manufactured using EPDM (ethylene propylene diene monomer rubber) and are appropriate for use for most water and wastewater applications. It is recommended to check with connector manufacturer for any specific concerns.

3.3.2 Petroleum (Oil) Applications – Nitrile or neoprene connectors are typically required for this type of application. It is recommended to check with connector manufacturer for any specific concerns.

3.3.3. Corrosion or High Temperature – Stainless steel hardware can be used instead of galvanized hardware in areas where corrosion could be an issue. For high temperature situations, silicone is recommended.

4. Proper Backfill

Proper backfilling of underground precast concrete structures is key to long-term performance. When tanks are adjacent to each other, it can be challenging to properly backfill and consolidate with native material or imported fill. Therefore, when backfilling is required around tanks, it is recommended that designers allow a minimum 36 inches of space between tanks to allow for proper backfilling. This will also allow for proper support of the tank walls.

Concentric backfilling and proper compaction per standard industry standards is required to prevent damage and movement between precast base and riser sections. Avoid any eccentric backfilling on just one portion or side of the tank. **Backfill consistently around the perimeter.**

Backfilling around the pipe, especially in tight areas between tanks, should be carefully planned and executed. Rigid pipe must be properly supported from the bottom. Carefully compact the trench under the pipe to avoid the pipe bowing between tanks and possibly suffering damage.

If adjacent tanks are installed with smaller separation distances, (i.e. less than 36 inches), flowable fill is a good option to use between tanks to fill the gaps. For multiple parallel tanks, consider using conveyor system to assist with proper backfill.

Above all else, follow tank and pipe manufacturer backfill requirements to avoid issues.

5. Buoyancy Considerations

Designing the tanks to resist buoyancy forces is very important. First off, the design engineer should conduct thorough research to review and investigate the plans, specifications and soils reports to gain more insight about the project and the underground conditions. If there are no soils reports or previous information available on the water table levels and fluctuations (seasonal and regional), engineers should design the structure on the conservative side, meaning designing a structure with the water level at grade, even if flooding in that area is not common. A conservative design approach may contribute to offsetting unnecessary and unforeseen cost when sufficient information about the soil/site conditions is unavailable.

It is recommended that the designer choose an appropriate factor of safety (FS) after reviewing information about the jobsite. In situations of flooding to the top of the structure and using dead weight resistance only, a FS of 1.10 is commonly used. In flood zone areas, or where high groundwater conditions exist, a FS of 1.25 should be considered. Where maximum groundwater or flood levels are not well defined, or where soil friction is included in the flotation resistance, higher FS values such as 1.5 should be considered. The engineer of record should select the appropriate FS based on site conditions.

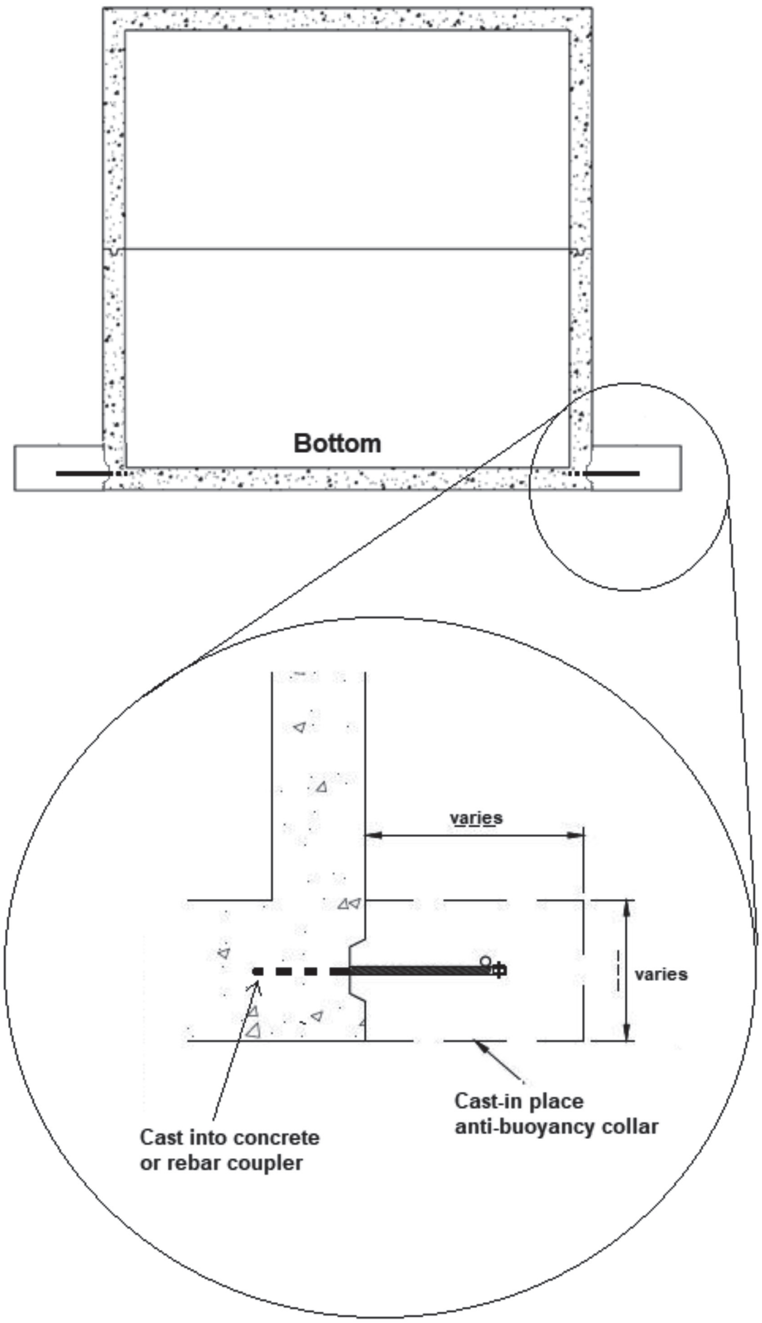
Using the additional weight of soil by adding a shelf is a common practice used to counteract a buoyancy problem. By extending the bottom slab of the structure horizontally, this creates a shelf outside the walls of the structure and adds additional resistance to the buoyant force. The additional vertical downward force comes from the additional weight of the soil acting on the shelf and the weight of the additional concrete in the shelf. The size of the shelf can be designed however large and wide is needed to resist the buoyant force.

Another method that is used to overcome buoyancy is to increase the weight of the concrete structure. This can be accomplished by increasing concrete thickness (i.e. walls and slabs).

Another possible solution is to design precast tanks with exterior "Shear Keys" allowing field cast anti-buoyancy flange.

A buoyancy guide and calculator are available on the NPCA website at precast.org/resources/specifiers

Tank Side View



6. Venting

Depending on the purpose of these multiple tanks, vents may need to be installed. Vents are needed especially when sanitary, stormwater or potable water will be flowing in or through the tanks. As liquid levels increase or decrease, the air in the tank will compress or cause a vacuum, and this pressure could be substantial. A venting system will relieve that pressure. Vents should be sized appropriately by the engineer based on the incoming pipe size.

These vents can be cast into the tank during manufacturing and should be properly bedded during backfill.

7. Tank & Connector Testing Methods

On some projects, there may be requirements in place to test tanks and connections for watertightness. There are a couple of ways to do this.

7.1 Vacuum Testing – Vacuum testing is an efficient way to test tanks for watertightness and exerts equal pressure on all surfaces. Vacuum testing should be performed as per ASTM C1227 - Standard Specification for Precast Concrete Septic Tanks, ASTM C1613 - Standard Specification for Precast Concrete Gravity Grease Interceptor Tanks or if field tested, as per ASTM C1719 - Standard Test Method for Installed Precast Concrete Tanks and Accessories by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

Many precast manufacturers conduct vacuum testing at their facility as part of their quality control program. If tanks need to be tested in the field, they should be tested prior to backfill. This helps ensure proper pressure can be applied without having to estimate additional pressures from soil and water.

7.2 Hydrostatic Testing – If water testing is specified, it involves placing water in tanks up to the highest outlet invert of the tank and waiting to determine watertightness. This is not as efficient as vacuum testing as pressure is not distributed evenly throughout the tank, it can be challenging to find enough water to fill larger tanks, and it takes longer, requiring wait times of 18 to 24 hours before the water level can be evaluated.

Hydrostatic test procedures are described in both ASTM C1227 - Standard Specification for Precast Concrete Septic Tanks and ASTM C1613 - Standard Specification for Precast Concrete Gravity Grease Interceptor Tanks. Always consult with precast tank supplier prior to conducting hydrostatic test.

Conclusion

When considering applications with multiple tanks, it is strongly recommended to contact your precast concrete manufacturer and include them in system design discussions. Manufacturers can bring some valuable wisdom and experience when deciding on sizing and layout, saving time and money down the road. They will be able to recommend what pipe connections can be used where and the appropriate distance needed between tanks to inspect and maintain these connections.

Multiple tank installations are increasing as larger wastewater treatment or utility systems are being designed. Precast concrete is well suited for these types of systems. Rely on your local manufacturer to help make every project a success.

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