PRELOAD

Prestressed Concrete Tanks

Design & Construction
The PRELOAD Advantage

PRELOAD has maintained a focused vision on designing and constructing the highest-quality and most-durable liquid storage tanks for over 80 years. From the first-ever wire-wound, prestressed concrete tank to the advanced tanks of today, PRELOAD’s legacy is built on the design and construction of more than 3,700 tanks worldwide.

PRELOAD tanks are designed and constructed to meet or exceed applicable industry requirements as contained in the following:

- American Water Works Association (AWWA) D110, Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
- American Concrete Institute (ACI) 372R, Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.
- American Concrete Institute (ACI) 350, Code Requirements for Environmental Engineering Concrete Structures.
- National Fire Protection Authority (NFPA) 22, Standard for Water Tanks for Private Fire Protection.

Singular Responsibility

From detailed tank design through completed construction, PRELOAD provides “singular responsibility” for all our clients. Singular responsibility ensures every project detail is exceptionally managed, including implementation of the highest-quality standards and processes necessary to provide a virtually maintenance-free liquid storage solution.
Quality tank construction always begins with a solid foundation. Various foundation considerations must be addressed to ensure long-term tank reliability and efficient construction.

1. PRELOAD engineers perform a geotechnical review on each project to assist in evaluating subsurface conditions.
2. PRELOAD collaborates with the design team to select an appropriate foundation based on tank loads, site soil conditions and hydrology.
3. A tank floor design is prepared based on the site-specific geotechnical considerations.

A minimum six-inch thick leveling course of granular material is placed on top of the subgrade to create a free-draining work area and foundation that ensures the construction tolerance is met in the thickness of the finished floor. That layer is then covered with a polyethelene liner that maintains subgrade consistency and allows for any drainage to consolidate.

**Under-Floor Piping**

Under-floor piping options are typically incorporated to meet the liquid transmission requirements of the design.

Time-tested construction practices are utilized, which result in watertight service and ensure:

- Proper installation of the piping to exacting tolerances.
- Exceptional concrete encasement of underground and internal pipes.
- Flexibility to allow differential settlement or movement of the piping relative to the tank structure.
- Watertight pipe integration with a waterstop ring embedded in the concrete floor.
Concrete Membrane Floor

For typical shallow foundation applications, a concrete membrane floor is utilized. The membrane floor is highly-reinforced concrete and constructed with an integral, monolithic footing that serves to transfer the loads from the tank wall and roof to the subgrade. Likewise, the floor transfers the liquid load directly to the subgrade and contains the liquid within the tank. The flexibility of the membrane floor allows it to accommodate differential settlement without being subjected to high secondary-bending stresses.

Concrete Structural Floor

Where a deep foundation support is required or as other site conditions warrant, a concrete structural floor is selected. The structural floor is compatible with various pile types, rock anchors and other specialty foundation systems. When a structural floor is chosen, design details and construction procedures are utilized that are compatible with the foundation elements.

PRELOAD floor systems utilize a custom-designed PVC waterstop installed at the floor-wall connection to ensure watertightness and accommodate lateral translation of the tank wall during operation.
The PRELOAD Team's experience in tank foundation design and construction are unequaled in the industry.
The tank wall is constructed using precast wall panel fabrication and erection techniques as specified in ACI 372R and further delineated as Type III in AWWA D110. Precasting methods for PRELOAD wall panels provide an unequaled level of quality control and represent the most advanced innovation in tank wall construction methods.

Tank wall panels are precast on-site around the perimeter of the tank. Panels are constructed through an efficient stack-casting process in casting beds shaped to the curvature of the tank wall. Prior to casting panels, a layout is prepared to show the panel bed locations relative to the tank structure. This method of construction is highly adaptable to any site condition.

**PRELOAD’s Precast Wall Panels are Constructed Using the Following Steps:**

1. A steel diaphragm is used as the bottom form in fabricating each panel.
   - The steel diaphragm is vertically ribbed with reentrant channels, providing a mechanical keyway anchorage to the concrete when cast.
   - The individual steel diaphragm sheets within a single panel are mechanically seamed to produce an impervious membrane throughout the entire wall.
2. Forms are positioned at the panel edges.
   - PRELOAD’s specially-developed form system provides positive control over the panel thickness and cover over the reinforcing steel.
3. Vertical reinforcing and lifting inserts are placed in the panel.
   - The combination of the steel diaphragm and vertical reinforcement counteract stresses due to differential temperature gradients and vertical bending moments.
4. Concrete is placed and finished to the curvature of the tank wall to form the inside face of the tank.
5. Panels are carefully cured to ensure proper strength and durability.

*When required, PRELOAD embeds inserts to support internal tank accessories. Wall penetrations that accommodate permanent manholes and through-the-wall piping are made watertight by sealing them to the steel diaphragm.*

**Precast Panel Benefits**

**Quality:** PRELOAD’s Type III precast panels are created under industry-leading quality control processes that ensure optimal wall thickness, and cover over the steel diaphragm and reinforcing steel.

**Durability:** The minimum 4-inch thick reinforced precast panels ensure greater durability than any other type of tank structure.

**Reliability:** Precast panels with an integrated, impervious steel diaphragm ensures a reliable tank structure which will serve the community for generations.

**Safety:** Panel construction on the ground minimizes aerial work, thereby ensuring unequaled safety in tank wall construction.
Tank wall panels are precast by the PRELOAD Team on-site and shaped to the proper curvature of the tank radius. Panels are constructed in casting beds and then stack-cast in an efficient assembly-line process.
Once all wall panels are cast, the individual panels are rotated vertically and erected along the perimeter tank footing. The panels are then temporarily braced as the wall construction continues to help ensure safe construction in nearly any weather condition.
Safe and Efficient Precast Wall Panel Erection Follows a State-of-the-Art Process:

1. Lifting equipment and rigging is inspected, then secured to the embedded panel lifting inserts.

2. An appropriately sized crane lifts individual panels that are rotated from horizontal to vertical during the tilt-up construction.

3. The crane positions and places the panels in alignment atop the circumferential tank footing.
   - The lifting crane operates from preselected positions to minimize the distance between the panel casting beds and the final panel position of the panels.

4. As the wall panels are placed in their final location, they are positioned on elastomeric bearing pads.
   - Elastomeric bearing pads are designed to allow the wall to translate and rotate freely, thus eliminating the high bending moments inherent in the fixed or hinged connections of other tank designs.

5. Each panel is stabilized during erection using specially designed bracing systems. The bracing systems resist temporary construction loads, such as those resulting from severe weather. These temporary braces assure stability and safety during construction.

6. The steel diaphragm is joined together and sealed between panels to produce a continuous impervious membrane.

7. High strength shotcrete or concrete is used to fill the vertical joints between the individual panels.

8. A minimum ½-inch of shotcrete is placed on the outside face of the steel diaphragm in preparation for the wire-winding operation.

Safety & Quality is Our DNA
PRELOAD's culture of safety is engrained in the company’s processes and practices. On-site safety leadership and training are part of our continuous improvement programs.

A set of quality-control metrics are checked at each step in the construction process to ensure each tank meets PRELOAD’s highest standard of quality.
Most PRELOAD tanks incorporate a cast-in-place, free-spanning spherical dome roof. PRELOAD’s design results in uniform compression throughout the dome shell. This allows for the use of an economical concrete section to span large tank diameters without the need for interior column supports.

The dome shape provides a low-profile, aesthetically pleasing structure. Rise-to-diameter ratios of 1:8 to 1:12 are standard, depending on tank diameter; however, other rise-to-diameter ratios are available upon request.

**Dome Roof Construction**

1. A custom dome-form design is prepared by PRELOAD’s engineering department.
2. Shoring towers are erected on the interior of the tank to support the dome form.
3. Dome ribs are cut to the specific curvature of the dome and installed on beams supported by the towers.
4. The dome form is completed by placing form material on top of the dome ribs.
5. Reinforcing steel or welded-wire reinforcement is placed throughout the dome shell.
6. A thickened fillet section is incorporated at the dome perimeter to resist the bending moments in the shell edge.
7. Dome penetrations for hatches, vents, pipes and accessories are installed.
8. Concrete is placed onto the form using conventional placing methods.
9. Concrete is finely screeded and finished to the required spherical shape, assuring uniform dome thickness.
PRELOAD Dome Design

Standard domes include venting to minimize internal air-pressure variations, an access hatch for future entrance and penetrations to incorporate tank level gauges. Penetrations for other accessories including roof inlet pipes, wash-down systems, odor-control sleeves, aerators and gas collection systems can also be easily incorporated.

Flat-Slab Roof Design

At times a flat-slab, column-supported roof is required for fully buried tanks, for a project’s height restrictions, or for aesthetic reasons.

PRELOAD’s flat-slab roof is supported by circular columns, each with a footing sized for the allowable soil-bearing capacity. To economize the design, column capitals or drop panels are used that are compatible with the roof design.
The unique process of single-wire, circumferential prestressing is applied to the exterior of the wall. This time proven method, invented by PRELOAD, places the entire tank wall into a state of permanent compression. Maintaining the tank wall in a continuous state of compression prevents cracking and leaking under all service conditions. In addition, prestressing the dome edge also keeps it in compression, enabling the use of large-diameter, free-spanning, concrete domes.

Prestressing wire is applied around the tank in a continuous helix, using custom designed machines capable of exceeding industry standards for force tolerance and meeting PRELOAD’s own stringent quality requirements.

- Each wire is stressed to the design force within tight tolerances prior to being placed on the wall. This ensures no movement of the wire in relation to the wall.
- The actual wire stress is confirmed during prestressing to ensure that the applied force is in accordance with the design requirements.
- A minimum clear distance between individual prestressing wires is maintained to ensure that wires are fully encapsulated with shotcrete between multiple layers of prestressing.
- A shotcrete wire-coat is applied to encase each individual wire, creating a bonded prestressing system.

The Superiority of Single-Wire Prestressing

**Quality:** Positive control and consistent force in each wire ensures uniform compression in the core wall around the tank circumference.

**Durability:** Single-wires are shotcrete-encased individually providing superior protection from corrosion.

**Reliability:** Applying individual wires helically eliminates the need for buttresses and anchorage zones, resulting in the highest level of reliability.

**Safety:** Efficient mechanical application of single-wires, rather than groups of strands with high tensile forces, facilitates safe construction.
Circular, single-wire prestressing is the time-proven method PRELOAD invented for constructing wire-wound prestressed concrete tanks. Prestressing places the entire tank wall into a state of permanent compression. This prevents the cracking and leaking associated with other types of concrete tank structures.
Cover Coat & Finish Coat

An exterior shotcrete cover coat is applied to the tank wall. This step is accomplished through a pneumatic shotcreting process. PRELOAD also uses shotcrete to cover the steel diaphragm and each individual prestressing wire. During this process, concrete is applied or “shot” onto the wire and wall with air pressure, typically in layers.

The cover coat of cement-rich, dense shotcrete serves to protect the prestressed reinforcement from corrosion and mechanical damage. This cover coat is applied by skilled nozzlemen to ensure a high-quality product.

The final surface of the tank, known as the finish coat, is architecturally finished by applying either a natural gun or a steel troweled finish to produce a durable and aesthetically pleasing tank structure. A decorative coating can be applied to the tank exterior if desired for aesthetic purposes, but is not required.

Many architectural treatments are available for the prestressed concrete tank structure. Intermittent vertical pilasters built of shotcrete or brick are one example of the geometric and textured treatments that can be incorporated to blend the facility into the surroundings.

Certified Shotcrete Nozzlemen
The shotcrete used in the construction of a PRELOAD tank is an important final step in ensuring a durable tank structure. The shotcrete is applied by our skilled nozzlemen who are certified in accordance with American Concrete Institute (ACI) C660 Shotcrete Nozzleman Certification Program to ensure the highest quality tank construction.
Accessories

After the construction of the tank is complete, accessories are added to complement the tank structure based on specific project requirements. Accessories are fabricated from premium materials to assure durability and virtually no maintenance, reducing or eliminating costly service interruptions for the life of the tank structure. Like the tanks themselves, accessories are designed to comply with all applicable local, state and federal regulations. Accessories include: personnel and equipment hatches, washdown systems, odor control sleeves and tank mixing systems.