CONSTRUCTION PROCEDURES

AWWA D110 Type I Prestressed Concrete Tanks
At DN Tanks, we understand that a liquid storage tank is a critical component of infrastructure that serves a variety of storage needs, such as a community’s potable water source, fire suppression source, an important step in the treatment of wastewater, a consistent source of recycled water, as well as many other uses. Each of these tanks are instrumental to the communities they serve.

DN Tanks’ prestressed concrete storage tanks are individually designed with a full structural analysis to meet specific project needs. Quality, durability, and efficiency are ensured through specially trained and skilled field crews, advanced prestressing technology, and professional project management.

Over 50 years of experience are ingrained into each AWWA D110 Type I prestressed concrete tank. Our years of commitment and focus in the prestressed concrete tank industry have cultivated expertise in engineering, estimating, project management, and construction. From project development and design assistance to construction and prestressing, DN Tanks’ dedicated team is ready to provide support services to ensure a successful tank project. We measure success by our lasting partnerships with clients and communities.

**KEY ATTRIBUTES OF DN TANKS’ AWWA D110 TYPE I PRESTRESSED CONCRETE TANKS**

- **Tank Capacities** - from 40,000 gallons to 50 million gallons (MG) and above
- **Custom Dimensions** - water heights from 8’ to over 100’ and diameters from 25’ to over 400’
- **Siting Options** - at grade, partially buried, differentially backfilled (hillsides), fully buried (with multi-use capabilities)
- **Seismic Resilience** - proven performance through Loma Prieta, Nisqually and Northridge earthquakes to name a few
- **Enhanced Ductility** - anchored flexible base and roof connections
- **Bi-axial Wall Compression** - provides longevity, durability and liquid tightness
- **Best Long-term Value** - coatings aren’t required thus eliminating routine maintenance costs and down-time burdens
- **Reinvesting in the Local Economy** - use of materials, labor and equipment from within the community
- **Enhanced Water Quality** - concrete inherently insulates, keeping liquids at a more consistent temperature
SITE PREPARATION

A properly prepared subgrade is essential to tank construction. Before the structural tank design begins, a licensed geotechnical engineer prepares a site specific geotechnical report. The report provides design parameters that include bearing capacity, anticipated settlements, seismic criteria, and recommended subgrade and foundation preparation.

- Subgrade preparation for each tank is completed in accordance with the civil site plans and the site specific geotechnical report
- Piping connections that penetrate through the floor (e.g. inlet, outlet, overflow, etc.) are encased in underslab concrete pipe blocks
- A waterstop is incorporated between the floor and pipe block to ensure a liquid tight connection
- Wall and roof pipe penetrations can be easily incorporated
A typical prestressed concrete tank floor consists of the following features:

- A cast-in-place, highly-reinforced, concrete membrane floor with a slight upward slope to the center allows for drainage
- Monolithic or large section pours limit joints to improve tank performance and achieve construction efficiency
- A thickened perimeter wall footing to transmit the concentrated wall loads to the subgrade beneath
- A permanent PVC waterstop at all joints for water tightness
- Seismic base restraint cables are developed into the perimeter footing to account for site specific seismic loading
- Structural observation is performed by a Registered Engineer prior to the concrete pour
- Experienced field crews place the concrete and ensure it is vibrated, screeded, and finished to meet the project specifications
CAST-IN-PLACE WALL CONSTRUCTION

Prestressed concrete places steel in tension and concrete in compression, allowing for both materials to resist forces in their ideal states. The corewall is designed to account for project specific parameters and loadings. A typical tank corewall consists of a 10” minimum uniform thickness. For larger capacity tanks, walls may be thicker and tapered on the inside face to accommodate increased loads.

FEATURES OF AN AWWA D110 TYPE I WALL

Enhanced Operational and Seismic Performance

• “Anchored flexible base” connection between the floor and wall (similar to a base isolation system) enhances ductility and reduces bending moments from hydrostatic, thermal, and seismic forces, allowing these structural elements to act independently

• Seismic base restraint cables anchored into the footing extend into the corewall, providing load transfer during a seismic event

Quality Control

• Circumferential wall forms curved to the specific tank radius are equipped with equally spaced pour windows to enhance quality control, reduce overall drop height, and allow ease of access for concrete placement and vibration

• Walls are poured full height in up to 50’ wide circumferential sections

• Rebar congestion is significantly reduced, promoting more efficient inspection and concrete placement

Liquid Tightness and Durability

• Vertical prestressing threadbars cast in the wall provide vertical compression and minimize vertical bending moments caused by differential temperature and dryness conditions

• Horizontal joints are eliminated and vertical joints are minimized to provide superior water tightness

• All construction joints incorporate permanent PVC waterstops
ROOF OPTIONS

Prestressed concrete tanks can be designed with a variety of roof options.

FLAT ROOF FEATURES

- Low profile cast-in-place, two-way flat slab roof minimizes visibility
- Option to bury or accommodate multi-use structures such as parks, recreation facilities, pump stations, etc. on the tank roof
- An anchored flexible wall/roof connection allows for thermal expansion of the roof slab while also providing seismic restraint
- Evenly spaced concrete columns, designed with drop panels and footings, support the roof and transfer the corresponding loads
- A slight upward slope to the center, matching the floor, provides drainage

DOME ROOF FEATURES

- A clear-spanning concrete dome with no interior supports or obstructions can easily accommodate various equipment needs
- Typical dome height is 10% of the tank diameter
- Continuous reinforcement is incorporated in both radial and circumferential directions
- Circumferential prestressing applied at the dome ring places the dome in permanent compression
VERTICAL PRESTRESSING

AWWA D110 Type I tanks incorporate vertical prestressing threadbars within the wall to provide vertical compression and counteract bending. Features include:

- High-strength steel threadbars are either 1 ¼” or 1 ¾” diameter depending on corewall thickness
- Threadbars are equipped with a screwed-on nut anchor at the top and bottom to eliminate stress concentrations
- Each threadbar is housed inside of a rigid PVC pipe to allow for proper installation
- A hydraulic ram is used to tension the threadbars after the concrete walls are poured
- Threadbars are tensioned to 137 kips or 173 kips for the respective diameter, with a tight force tolerance of 1.5%
- Force and elongation recordings are electronically and instantaneously produced for each vertical threadbar, documenting the applied stress
- After tensioning, threadbars are pressure grouted from the bottom up with a two-part epoxy to achieve a fully bonded system and corrosion protection
ABRASIVE BLASTING

Prior to starting circumferential prestressing and shotcrete operations, DN Tanks’ advanced abrasive blasting system roughens the exterior corewall surface. System features include:

- Automated hydroblasting applies water at a high pressure of up to 40,000 psi to etch the wall to a precise roughened finish, providing a superior bonding surface
- An automated system reduces jobsite hazards, optimizes construction schedule and provides a consistent finish
- Hydroblasting is environmentally friendly as it requires very low water usage and eliminates dust
CIRCUMFERENTIAL PRESTRESSING

Circumferential prestressing is the heart of the tank structure, counteracting the liquid load and placing the tank wall in 200 psi residual compression. DN Tanks’ significant industry advancements includes the automated machine application of tensioned, hot-dip galvanized, \( \frac{3}{8} \)" diameter 7-wire strand. By placing the strand in tension, and thereby the concrete wall in compression, the prestressed concrete tank incorporates both materials in their ideal states.

The mechanical prestressing system allows application of a consistent prestressing force of 14,950 pounds with a tight tolerance of 1.5% of MUS. This greatly exceeds the AWWA minimum standard accuracy of 7% of the applied force. Strand is tensioned to 70% of MUS, placing the wall in permanent bi-axial compression to withstand the varying operational hydrostatic loads, as well as thermal and seismic dynamic loads.

BENEFITS OF STRAND-WRAPPING:

- Improved accuracy & efficiency
- Tighter force tolerance
- Electronic spacing & recording
- Fewer splices
- Increased shotcrete bond
- Greater safety factor
Continuous electronic recording and instantaneous self-correcting force application are essential to ensure the proper stress is applied to the prestressing steel. The prestressing steel places the concrete into permanent compression and resists all hydrostatic loads. It is imperative that the stress is applied accurately. The automated system offers:

- Computerized, continuous electronic force readings for the highest quality control
- In-line calibration allowing for instantaneous control of the force applied
- A record of the force readings submitted to the Owner, providing confidence that the most critical part of the hydrostatic resistance has correctly been applied
AUTOMATED SHOTCRETE

The advanced technology of the automated shotcrete process is proven to preserve the integrity of DN Tanks’ structures by providing corrosion protection and a permanent bond.

FEATURES OF AUTOMATED SHOTCRETE

• Control of numerous variables such as uniform distance, angle, and applied thickness on large surface areas ensure complete encapsulation of the prestressing strand as well as a proper bond to the corewall.

• Wet-mix shotcrete applied from a nozzle mounted on a mechanized tower travels at a controlled uniform speed and path.

• A minimum final shotcrete cover of 1.5 inches, built up in multiple layers.
APPURTENANCES

Prestressed concrete tanks can accommodate a variety of accessories, such as roof and wall access hatches, interior and exterior ladders, vents, safety railings, level sensing equipment, or specialized security hardware. Our experienced team can help recommend and install appurtenances to meet specific project requirements.
1 PVC Waterstop
2 Elastomeric Wall-Base Bearing Pad
3 Tank Foundation
4 Vertical Prestressing Threadbars Housed in PVC Pipe
5 Cast-in-Place Concrete Corewall
6 Seismic Base Restraint Cables
7 Continuous Circumferential Reinforcing
8 3/8" Ø 7-Wire Galvanized Circumferential Prestressing Strand
9 Shotcrete Encasement
10 Roof Shear Can
11 Wall Shear Can
12 Elastomeric Wall-Top Bearing Pad