Internally Cured Concrete Holds Water in Denver



Since the 1930s, Denver Water's North System has been a source of clean water critical to sustaining a vibrant city and its surrounding suburbs. Now, 80 years later, this water system that brings snowmelt from the mountains through reservoirs, pipelines, and into a treatment plant is in dire need of replacement to ensure the reliable delivery of safe drinking water to 1.5 million people every day.

Denver Water's new Northwater Treatment Plant (NTP) is part of a multiyear project that will help reduce service failures and meet the water-quality needs of the future. The state-of-the art facility features multiple buildings and auxiliary structures—including two massive concrete tanks for storing treated water. With a height of 23 feet (mostly underground) and a diameter of more than 300 feet, each tank can hold 10-million gallons of water, the equivalent of 15 Olympic-size swimming pools.



THE CHALLENGE

Colorado's very dry, desert-like climate makes constructing large capacity, monolithically placed water storage tank slabs a complex proposition. As concrete hydrates, its surface moisture is rapidly absorbed, which inherently creates a stress at the top portion of the concrete. When that stress exceeds the strength that has been gained, cracking occurs on the surface.

Denver Water is constantly looking to improve the longevity and performance of its water storage tanks—ultimately focused on tanks that last for a significant amount of time, without leaking. To achieve these goals for the NTP tanks, the project team needed an advanced low-shrinkage, high-performance solution to reduce shrinkage cracking, enhance durability, and achieve a service life of 100 years.

With up to 400 people working on the jobsite and multiple mass concrete pours planned, logistical and safety challenges also needed to be addressed to ensure continuous on-time material deliveries while maintaining social distancing.

To meet the project's demanding performance goals, Denver Water and Bates Engineering relied on the experts at Holcim US, who developed an internally cured concrete (ICC) to mitigate shrinkage cracking in a water storage tank built in 2012. "Based on the significant reduction in maintenance costs and water leakage in this enormous post-tensioned concrete structure, this ICC mix has been our 'go-to' solution for building Denver Water tanks ever since," said Bob Bates, president of Bates Engineering.

The qualities of ICC that accomplish this are reduced shrinkage cracking, greater cement hydration, more constant heat of hydration, and decreased permeability, all of which extend the concrete's service life. For the NTP project, Holcim US produced high-performance ICC with prewetted expanded shale lightweight aggregates to achieve the desired placing, finishing, and strength properties for the floor slabs, walls, structural columns, and roof lids.

"To ensure the concrete pours went smoothly and safely, the project team also relied on Holcim's ConcreteDirect project coordination tool to keep critical construction going without compromising the need for social distancing," said Pat Bergin, sales manager at Holcim US. "This transparent and real-time mobile app was an easy way for hundreds of users on the jobsite to manage concrete orders, track the progress of deliveries, manage the flow of trucks to multiple pumping stations in the work zones, view specified quality-control tests, and receive touchless ticketing."

THE SOLUTION

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THE RESULTS

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In May 2021, Holcim US partnered with Garney Construction to plan and execute the production, delivery, and placement of more than 1,500 cubic yards of ICC for the floor slab of the first water-storage tank. It was critical that the concrete pours be continuous, and they required flawless execution by the project team to ensure that the massive slab was free of imperfections.

Throughout this enormous operation, the ConcreteDirect digital tool was instrumental in ensuring just-in time deliveries of 145 truckloads of the ICC and allowing everyone to perform their tasks safely. Ready-mix trucks from two local batch plants arrived at the jobsite every four minutes starting at 2:30 a.m., and the ICC was pumped and finished by a crew of 100 concrete construction workers through noon that day. Quality control teams conducted tests at every pump to ensure optimal results.

The floor slabs, walls, and columns of both water storage tanks were completed by first quarter 2022, and the roofs will be in place by early summer of the same year. Upon completion, the new durable, highperformance tanks will help ensure a reliable supply of clean drinking water to Denver residents for many years to come.

"We are very enthusiastic about the return on investment this ICC mix provides Denver Water in terms of reduced water leakage and maintenance costs, as well as enhanced durability and long service life," commented Bates. "Our use of the product not only immeasurably minimized cracks in the tanks but also reduced construction timelines by allowing the contractor to strip and set forms quicker."

