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CRACK-FREE CONCRETE CRITICAL FOR TANKS

In El Paso, Texas, Type K cement was used in the construction of two treatment plants, which are still virtually crack-free almost 20 years after they were built. This is no small feat in a city where high heat, low humidity, and sizeable temperature swings create less-than-ideal conditions for concrete structures.

"Controlling cracks is always a top priority in concrete structures, but when the structure is a containment tank, it is critical.

For years, containment designers have tried to achieve crack-free concrete. Techniques have included specific special mix designs, low water/cement ratios, many different admixtures, special aggregates, and supplementary cementitious materials – all with limited success. ASTM C845 Type K Shrinkage-Compensating Cement Concrete, which has been used since 1963, has become very competitive to the other shrinkage reducing concretes and still is the only solution that can provide a stable concrete from the plastic state to the hardened state. Type K is time-proven for use in structural concrete, including bridge decks, large commercial floors, post-tensioned structures and many different types of containment structures.

Most well-designed concrete is very durable. However, problems occur when concrete shrinks. Portland cements in hydration, by nature, expel or evaporate water causing the concrete to shrink and creating tensile stresses that can lead to cracks. In an attempt to control cracking, designers incorporate control joints. Properly designed joints work well, but in many cases, joints can become the weak link and the source of leaks.

Shrinkage-compensating concrete works exactly as its name suggests – it mitigates shrinkage. Manufactured by CTS Cement, Type K cement concrete can eliminate drying shrinkage and curling. Shrinkage compensating concrete initially expands as it cures, and then relaxes. Using traditional continuous steel reinforcing as the restraint produces controlled compressive stresses that counteract tensile stresses. Crack-free concrete sections are very achievable.

In addition to controlling cracks, Type K has other key benefits, including improved sulfate resistance, increased joint spacing, higher abrasion resistance than traditional portland cement concretes, and great workability. Fewer expansion joints saves construction time, reduces costly joint materials/sealants, and minimizes maintenance over the life of the structure.

Specified by consulting engineering firm Crawford Murphy & Tilly (CMT), Type K shrinkage compensating concrete was used for the Springfield Wastewater Treatment Facility Expansion in Springfield, Illinois, USA to mitigate shrinkage-related cracks. CMT also selected Type K to allow the contractor to extend joint spacing, which would reduce the schedule and construction costs. As the project progressed, additional structural elements were converted from portland cement concrete to shrinkage compensating concrete based on its performance and the costs associated with repairing cracks in portland cement concrete placements.

Neither the ready-mixed producer nor the general contractor had experience with shrinkage compensating concrete. Twelve 650- to 700-cubic-yard and a dozen 300- to 400-cubic-yard placements were completed using conventional equipment. Temperatures ranged from the 40s to

mid-90s Fahrenheit throughout the project duration. The mix design included fly ash and a mid-range water reducer. On the days when concrete temperatures exceeded 88 degrees, a high range water reducer was added to improve pumpability. In review of the concrete, cracking was eliminated and two additional treatment plant projects in Springfield are specifying shrinkage compensating concrete in 2011.

Another example is the Montebello Filtration Plant, located in Baltimore, Maryland, USA. The original reservoir was more than 70 years old, so the owner opted to remove the old reservoir and replace it with a new one with a desired lifecycle of 100 years. The designers, Dillion Engineering and WR&A, set out to produce a water-tight structure free from leakage and without cracks. More than 35,000 cubic yards of Type K concrete will be used on the project that is currently underway.

In addition to the Type K cement, slag cement was also added to the mixture to help with permeability and to make the concrete denser and more resistant to sulfates. This incorporation made the structure impermeable by creating enough expansion to prevent cracking.

Containment tanks are perhaps the most obvious place to use Type K cement concrete within water and wastewater treatment facilities. The slab-on-grade on which the walls sit is also a good candidate for Type K concrete usage because any joints in the slab are primary paths for water to seep through, making leaks difficult to diagnose without expensive monitoring equipment. Elevated walkways, tunnels and transfer structures can also benefit from crack-free concrete.

Written by: Ed McLean and Harry Moss, CTS Cement Manufacturing Corp.

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VOCABULARY LESSON

Shrinkage-compensating cement and shrinkage-reducing admixtures may sound like similar products; however, these are very different technologies and are under completely different ASTM standards. Shrinkage-reducing admixtures delay shrinkage but cannot compensate for shrinkage.

A study at the University of Oklahoma found that within days after placement, the portland cement concrete using shrinkage-reducing admixtures began to shrink. After 15 months, while the shrinkage-compensating concrete exhibited little to no shrinkage, cracks, or warping, the same could not be said for the shrinkage-reducing admixture concrete. Its surface had nearly the same amount of shrinkage, cracking, and warping as ordinary portland cement concrete. This research demonstrates the importance of specifying the correct technology in the concrete mix that is designed to improve the paste and effectively control shrinkage cracking of the concrete long-term.