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KOMPONENT

TYPE K MITIGATES CRACKING, INCREASES DURABILITY

Figure 1 – Stark Excavating places and finishes a Type K cement concrete bridge deck in Peoria, Illinois, over Boyd's Hollow Creek on Route 29. Concrete was supplied by VCNA Prairie.

On June 3, 2015, VCNA Prairie supplied Type K cement concrete for a new bridge deck in Peoria, Illinois, over Boyd's Hollow Creek on State Route 29. This concrete is part of a long-term study by the Illinois Center for Transportation (ICT) in an effort to mitigate cracking and increase durability on its bridge decks (ict.illinois.edu).

Stark Excavating placed the concrete and coordinated with the research team from the University of Oklahoma Fears Laboratory, who placed 31 strain gauges within the concrete. The gauges were placed on rebar and structural steel beams and were designed to take readings every minute for the first seven days and every hour for up to one year. The data generated provided valuable in situ information on the behavior of Type K cement concrete on complex bridge deck structures and validated the finite element models that were developed by the research team for this study.

Type K cement concrete was developed in the 1960s and is commonly used in bridge decks, containment structures, industrial floor slabs, parking structures and other post-tensioned concrete designs. Six Type K bridge decks were constructed in the early 1990s in central and southern Illinois.

After 20 years in service, these Type K cement bridge decks have proven their exceptional durability and crack mitigation performance. One of these bridges was completed in 1992 near Eureka on State Route 24 and is still in excellent condition.

The Ohio Turnpike Authority has been using Type K cement concrete on their bridge decks since the 1980s with great success. An article published in the 1993 issue of Concrete International illustrates the elimination of cracking on their decks by using Type K cement concrete. Figure 4 summarizes their bridge deck replacement program from 1983 to 1990.

Of the 303 bridge decks in the ICT study that were constructed with Type K cement, 11 decks showed some degree of cracking related to construction influencers. Five of the 11 decks were ramp structures placed while subjected to live load vibrations. Of the 71 bridge bridges constructed using Type I/II concrete, 53 decks showed signs of cracking. Three of these decks were subjected to live load vibrations during construction.

Excluding decks influenced by live load conditions during construction, only two percent of the Type K bridge decks exhibited minor cracking while 73.5 percent of the Type I/II bridge decks exhibited cracking and resulting deterioration.

The Boyd's Hollow Creek project utilized CTS Cement Manufacturing's Komponent® expansive cement additive to create Type K cement that meets American Society for Testing and Materials (ASTM) standard C845 for expansive hydraulic cement. Komponent replaced approximately 15 to 18 percent of the cementitious content of the mix. Dosage was determined by the characteristics of the local portland, aggregates, and other additives used in the mix design. It was added using a ChemGrout slurry machine to ensure proper mixing of the material prior to discharge into a ready mix truck.

HOW DOES TYPE K CEMENT CONCRETE WORK?

Type K cement is designed to compensate for the drying shrinkage that occurs in portland cement concrete. It is engineered to create controlled expansive forces that keep concrete in compression throughout its service life. The controlled expansion occurs as a result of ettringite formation during the hydration of this special cement additive. The controlled expansion occurs during the initial 7 day wet-cure, which puts the concrete into compression and the steel in tension early. In a bridge deck scenario, the minor controlled expansion (typically 1/32 to 1/4 inch based on design requirements and mix design) builds up tensile forces in the reinforcing steel that are relaxed when the portland cement begins its normal drying shrinkage. Portland cement's shrinkage results in net zero stresses within the concrete and prevents drying shrinkage cracking. By preventing drying shrinkage cracking, Type K cement concrete effectively produces a more dimensionally stable, durable concrete solution with lower lifecycle costs.

Type K is based on a high performance calcium sulfoaluminate chemistry. It is manufactured in much the same way as portland, with similar raw materials; however, the process and proprietary modifications produce a specialty cement chemistry that achieves distinctly higher performance characteristics. In addition, the manufacturing process uses a lower temperature during the "burn", which consumes less energy and emits 32 percent fewer carbon dioxide (CO_2) emissions. It also results in a cement clinker

that is much easier to grind, which also uses less energy. Lower energy consumption, lower CO_2 emissions, improved durability and lower lifecycle costs result in the most sustainable cement available.

Refer to American Concrete Institute (AC/) 223, "Guide to Shrinkage-Compensating Concrete': for more information.

Figure 3 – Workers using a bull float to apply a smooth finish to the Type K cement concrete pavement.

CTS Cement Manufacturing Corp. is the leader in advanced cement technology. They have an extensive history of providing innovative, high-performance cement products to the construction industry. As the leading manufacturer of calcium sulfoaluminate (CSA) cement in the United States, CTS offers two distinct product lines: Rapid Set®, a full line of professional-grade, rapid hardening cement engineered for high performance, rapid strength gain, low shrinkage, and reduced installation times and maintenance requirements; and Komponent® shrinkage-compensating cement. line engineered with Type K cement technology that allows you to alleviate curling and drying or control joints and shrinkage steel requirements. Both product lines utilize CSA cement technology to help prevent costly concrete deterioration, repair and failure, and are renowned for their proven, high quality performance and exceptional service life.

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Figure 2 – CTS Cement Manufacturing's Komponent expansive cement additive is added using a ChemGrout slurry machine

ACHIEVE AN "IDEAL BRIDGE DECK"

HOW DOES (TYPE K) EFFECT MAINTENANCE COSTS?

"The answer is quite simple, it is very low cost to maintain the Shrinkage-Compensating Concrete decks - no deck delaminations, spalls or steel corrosion."

OHIO TURNPIKE AUTHORITY

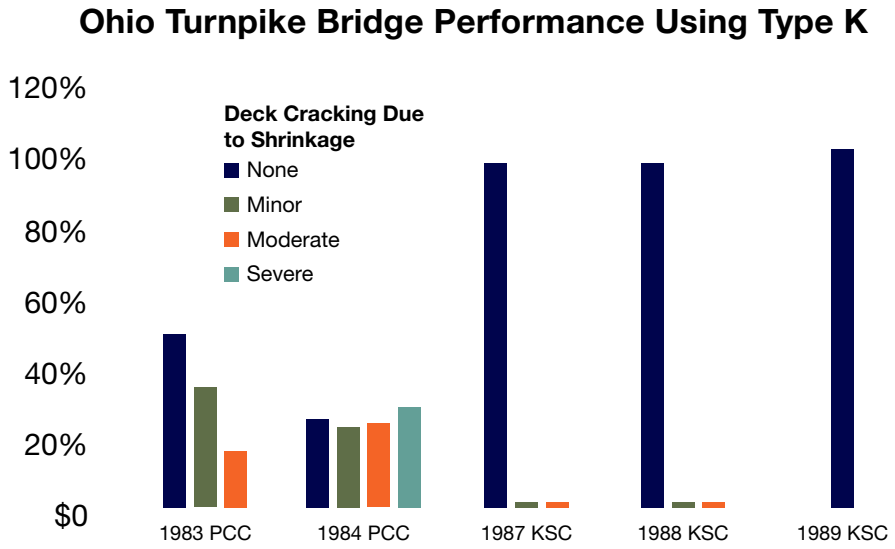

Figure 4 Type K performance chart of the Ohio Turnpike Bridge.