Special K Concrete Gaining Traction

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Among concrete producers in the Pacific Northwest, a new product is gaining traction: KSC System-K shrinkage-compensating concrete, a mix that includes Type-K expansive cement.

While Type-K cement has been available for 45 years, the technology enabling its use in concrete has continued to evolve. Today, it is increasingly in demand as a solution for floor slabs due to its ability to reduce or eliminate control joints, curling, and drying-shrinkage cracking.

Pictured above during construction, the Parr Lumberfloor features no joints, thus no curling to create hazards and wear on the forklifts that carry loads over it.

The promise of a jointless floor holds significant appeal for designers and owners; thus, System-K is being specified in a growing number of commercial, industrial and institutional projects. Although reasons for choosing it vary from the obvious to the unexpected, word of the new concrete is rapidly spreading. To date, three producers have dedicated silos to the specialty cement as demand continues to escalate.

EXPANDING TECHNOLOGY

Invented in the early 1960s, Type K is a mixture of an expansive-cement component and standard portland cement. It proved to be the most reliable and successful form of expansive cement for the production of shrinkage-compensating and chemically prestressed concrete. Besides resisting drying-shrinkage cracking and reducing or eliminating the need for control joints, shrinkage-compensating concrete prevents the curling that occurs, typically at joints, when a top surface dries more quickly than the bottom, causing uneven shrinkage.

The material enjoyed widespread use in the 1960s and '70s in a variety of applications, including bridge decks, airport runways, parking garages, hydraulic projects, and other installations where cracking and jointing were deemed unacceptable or undesirable. In the 1980s, a general cement shortage caused a huge drop in Type-K cement output, because cement producers were functioning at full capacity to meet demand for conventional powder, temporarily lowering the Type K market profile. Nonetheless, Type K has remained continuously available and in use. All bridge decks on the Ohio Turnpike, for example, built over the past 40 years have incorporated Type K concrete.

Cypress, Calif.-based CTS Cement Manufacturing — direct successor to the company that originated and patented Type K — has continued research to improve the technology of expansive-cement concrete. It has created a family of products, marketed under the KSC brand umbrella, to facilitate various types of projects. For large operations, as well as jobs where expansive cement must be shipped long distances, the most feasible option is KSC Komponent, offered as pure expansive cement to be mixed with local portland powder. Greater convenience is provided by a complete premixed cement formulation, KSC Type-K. The most recent innovation is a full concrete-producing system, KSC System-K, which includes the expansive component and

At Evergreen High School in Vancouver Wash, a wood gym floor laid over unjointed System-K Concrete placed on steel decking suits championship basketball teams whose performance cannot be compromised by substrate curling and cracking.

an optimized reinforcement fiber that provides internal restraint for shrinkage compensation. The latter system has been attracting considerable attention in Oregon and Washington.

The Portland Ore., Old navy retail outlet required floors with minimal joints for improved appearance, and safer navigation. A light sandblast finish was completed before sealing the floor.

intelligent marketing by a local concrete producer. Dave Frentress, marketing director of Glacier Northwest in Portland, Ore., recognized the product's potential when his company filled an order for a Type K floor specified by an in-house architect of the Fred Meyer Store chain. Highly impressed with the results, Frentress included a profile of the project in a newsletter circulated to 10,000 architects, engineers, owners, and previous accounts. The response was a slow, but steady growth in orders for reduced-joint or jointless floors.

A subsequent, high-profile Type K project was the Old Navy store at Lloyd Center Mall in Portland. The owner's primary concern was avoiding the unsightliness and maintenance issues associated with random cracking. When the store's previous conventional concrete floor cracked badly, a repair effort involving a thin overlay proved inadequate. To preclude the same experience with a new installation, the owner turned to a local contractor for guidance. Accordingly, Type K was suggested by Greg Whitaker of Portland-based Whitaker Ellis Builders, a Glacier Northwest customer.

Adopting a more conservative approach, the Old Navy store owner chose not to take full advantage of the product's joint-reduction capabilities. Consequently, the floor was jointed in 30-ft. squares — still considerably larger intervals than advisable for ordinary concrete. Joints were aesthetically aligned with the building's support columns. The 6-in.-thick slab-on-grade was placed over a high-quality 15-mil. vapor barrier and reinforced with #4 rebar spaced at two feet on center. While Type K concrete had to be pumped 600 feet through a parking garage, given the store's location inside a shopping mall, the situation was manageable, since handling is virtually identical to that for conventional concrete. The flatwork was cured with moist, plastic-backed fabric, rewetted every other day. Whitaker found results of the Old Navy project so impressive that he later placed a jointless 30- × 40-ft. System-K floor in his private residence.

SMOOTH RIDE

Another early project Frentress generated through the newsletter report was a warehouse for Parr Lumber in Hillsboro, Ore. To nerve-racking effect, the company previously had experienced curling problems with its jointed concrete floors. "After five or six years," recalls Parr Property Manager Brad Farmer, "the jointed concrete floor pan-

els started to move up and down when the forklift passed over them. A little bump can sometimes make a forklift lose its load, if it's not tightly stacked."

The new warehouse was under construction and steel rebar for the floor already had been installed when Parr heard about shrinkage-compensating concrete. The company opted for a 120- × 80-ft. Type K floor with no joints or saw cuts, using the rebar already placed as reinforcement. No cracks or curling have appeared since the installation.

HIDDEN BENEFITS

System-K was widely specified for a series of Northwest region school projects — designed chiefly by Vancouver, Wash.-based LSW Architects. Spanning eight campuses, the projects incorporated both slabs on grade and concrete on steel deck designs, ranging in size from classrooms to long corridors to floors as large as gymnasiums.

Though most of the flatwork will never be seen by facility occupants, since the slabs will be covered with various flooring materials, the architect selected System-K to meet two primary objectives: 1) elimination of curling due to damage and maintenance problems it inflicts on tile and other floor coverings; and, 2) minimizing vapor transmission and its deleterious effects on floor treatments. Well suited to that purpose, Type-K cement has a high water demand and releases relatively little moisture as it cures. The continuous, jointless surface also minimizes ground moisture infiltration.

Rinker Materials in Vancouver, Wash., supplied System-K for several of the projects, including Union Corner High School and a K-8 school in Battleground, Wash. Commenting on the performance of System-K on elevated decks, Rinker Technical Services Manager Michael Rodriguez notes, "With ordinary concrete on mezzanine decks, we'll typically see cracking immediately, or six months later as things dry out. With System-K, they don't crack."

To satisfy the architect's desire for ultra-low vapor transmission, Rodriguez consulted the producer to identify a mid-range water-reducer compatible with the concrete system. Despite the unusual nature of the request, in view of Type-K's high water demand and virtual absence of bleed water, a suitable additive was determined.

The System-K manufacturer exercises a policy of active technical support for implementation of its KSC products. A local CTS team conducts prepour conferences on every project and sends a representative to every pour to assure best results.

A DIFFERENT JOINT

System-K supplied by Rinker was also used for two projects at Vancouver's Clark College, where Gaiser Hall was upgraded via renovation and new construction, while O'Connell Sports Center underwent remodeling. An unusual feature characterizes one area of Gaiser Hall: flatwork serving as a campus entryway was installed with joint-type cuts designed not to crack.

Typically, a joint cut into concrete creates a weak spot that will crack open evenly under the stress of drying shrinkage. By contrast, the decorative slab at Gaiser Hall displays joint-like patterns that are crack-resistant. Because open cracks were deemed aesthetically undesirable, System-K was employed to prevent cracking, even at weak spots created by the cut lines. Both Clark College jobs were cited in July 2007 by the Vancouver Business Journal as two of the

Since Dave Frentress (left) and Dru MacNeil of Glacier Northwest in Portland, Ore., dedicated a silo to Type-K Cement to fill one large order, demand for the special mix has been increasing.

year's top construction projects.

KEEPING CLEAN

A common incentive for selecting a jointless floor is improved cleanliness. Joints and cracks trap dirt and debris that can be difficult to remove, requiring on-

going maintenance and manpower investments. At facilities processing or storing food, the problem becomes especially critical, since joints and cracks can harbor microbial infestation.

Food processing facilities rank among the most complex KSC projects in the Pacific Northwest region. Project principals behind the Rainbow Glacier popsicle factory in Vancouver, and Amy's Kitchen processing plant in Medford, Ore., requested jointless floors to maintain hygiene. Both facilities feature floor surfaces contoured in complex slopes to direct liquids into drains.

For service bays at the Litha Motars Dealership in Medford, Ore., a diamond polish in combination with jointless construction provides a sealed surface, making floors easier to keep clean.

For Amy's Kitchen, a 180,000-sq.-ft. jointless concrete floor was installed by Medford-based LTM Inc., which dedicated an entire plant to the job for three months. According to Don Skundrick, LTM's operations vice president for the Southern Oregon Group, an ordinary concrete floor with slopes and drains would usually be "a classic case of a lot of cracks," thereby making System-K concrete the obvious choice.

The floor was placed and hard-troweled with "tremendous success," Skundrick notes. "I've been in this business over 40 years," he adds, "and I've never seen anything so crack-free." The exceptional outcome, especially in view of the difficulty of the pour and stringent concrete requirements, prompted LTM to submit the project to its state trade association for an Excellence in Concrete award.

LET IT SHINE

Another LTM project in southern Oregon highlights an often-overlooked property of System-K concrete. The new Lithia Motors dealership in Medford boasts a diamond-polished, 30,000-sq.-ft. jointless floor — in the service bays, not the showroom. As polishing produces a surface particularly resistant to staining and penetration by liquids, a polished System-K slab was determined best suited to meet the dealership's demand for durable flooring that could be easily maintained at a high level of cleanliness.

The polishing process, which involves the use of densifiers, was completed by Sustainable Flooring Systems (SRS) of Vancouver, Wash. SRS General Manager Brad Sleeper described the dealership's System-K concrete floor as "the best slab we've ever worked on." The surface took a high polish, indicating an extremely hard material.

Type K concrete is known to achieve generally higher compressive strength than ordinary concrete of similar mix design. Additionally, testing indicates approximately 40 percent higher abrasion resistance. In conventional concrete, bleed water brings soft fines and laitance to the surface, resulting in a top layer composed of softer materials than the interior of the slab. Ordinary concrete's bleed water also locally raises the water/cement ratio, making the surface concrete weaker than the mix design would predict. Because Type K concrete has little or no bleed water, the surface and interior are virtually identical in hardness and compressive strength.

"We got a great polish," Sleeper reports. "We stopped polishing at 800 grit, and it's one of the brightest and most reflective 800 grit finishes we've done. It would be comparable to a 1,500 grit polish on a standard concrete floor."

RESISTING SHRINKAGE CRACKING

All concrete shrinks as it dries. Water in concrete that has not been utilized in cement hydration occupies space; and as it evaporates, the volume of concrete is reduced, causing shrinkage. Typical 28-day shrinkage is approximately 0.04 percent, although it varies with mix design, aggregate properties, and environmental conditions. Shrinkage can continue for years.

In ordinary portland cement concrete that is externally restrained, e.g., a slab on grade restrained by friction with the subgrade, movement due to shrinkage induces tensile stress inside the concrete. When stress exceeds the material's very low tensile strength, cracking occurs.

Joints cut into slabs prevent random cracking by encouraging cracks to form in straight lines at regular intervals. Thus, joints constitute a workaround, a compromise rather than a solution. Even with jointing, random shrinkage cracks often appear in ordinary concrete slabs.

Concrete made with Type-K cement expands during the first seven days after hydration. During this curing period, it must be kept continually moist to promote proper expansion. Once expansion is complete, the concrete begins to shrink. Its initial expansion is approximately equal to its subsequent shrinkage, resulting in a net shrinkage very close to zero or sometimes a slight net expansion.

Type K concrete must be restrained during expansion. Accordingly, internal restraint can be achieved by means of reinforcing fibers or steel rebar. As expansion pulls on the reinforcement, putting it into tension, concrete is compressed by tensioned reinforcement acting in the opposite direction on concrete attached to it. Since concrete is strong in compression, tensile stress caused by shrinkage is thereby relieved, minimizing drying shrinkage cracking.

In the earliest applications of Type K concrete, reinforcement bars were the common form of restraint. Recently, an optimized, synthetic reinforcing fiber has been developed, eliminating the cost of steel and the labor to install it. Fiber reinforcement is suitable for most applications where steel bars are not needed for structural purposes.

LONG-TERM SAVINGS

LTM's Don Skundrick notes that shrinkage-compensating concrete's slightly higher first cost is offset by the elimination of material and labor costs for placing steel reinforcement, plus labor for joint cutting. Due to reduced maintenance, he contends, overall cost to the owner is lower than that for an ordinary concrete floor. "When you consider life-cycle cost," Skundrick emphasizes, "it's a value."

System-K is a particularly useful product in Southern Oregon, he adds, where highly absorptive aggregates encourage greater-than-usual shrinkage and, therefore, yield mixes highly prone to shrinkage cracking. "Even with great contractors," he says, "cracking issues arise with portland cement concrete. We think System-K is a significant solution — almost a silver bullet."

Regarding business prospects for System-K, Skundrick affirms, "We think the product will sell itself." As the list of projects in the Pacific Northwest continues to grow, creating greater awareness of System-K concrete and demonstrating its value to potential customers, that prophecy appears to be coming true.

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