

Kentucky's experience with rehabilitating PCC pavements with asphalt overlays



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Most of Kentucky's interstate and parkway systems were constructed in the 1960s and 70s. By the early 1980s, some of those pavements began to need rehabilitation.

When rehabilitating concrete pavements, a major consideration is how to address reflective cracking from the concrete into the asphalt overlays. This article summarizes the strategies the Kentucky Department of Highways (KYDOH) considered for rehabilitating concrete pavements with asphalt overlays.

One strategy considered by KDOH was to simply ignore reflective cracking and to place thick, conventional overlays. This approach was based on the belief that, if an asphalt overlay with sufficient thickness was placed, the temperature differential in the slab would be minimized and a one year delay in reflective cracking per inch of overlay thickness would occur. For thick overlays, several years would pass before the cracks re-appeared. A second option was to cut expansion joints into the concrete slab at periodic intervals and cover with a thick overlay. The goal was to control "slab action" by installing expansion joints at 800 to 1,000 feet intervals.

Another reflective cracking treatment strategy was to place a crack relief layer, usually an open-graded asphalt base, followed by an asphalt overlay. Still another option was sawing joints in the asphalt overlay to match the existing joints in the old PCC pavement and sealing with silicone or hot-poured rubber sealant (also known as saw-cut and seal). Other treatments included stress absorbing membrane interlayers (SAMIs) and geotextiles, paving fabrics and modified asphalt materials.

KYDOH eventually decided to primarily use a different strategy—fractured slab technology with asphalt overlays. Slab fracturing techniques considered included cracking, breaking and rubblizing. Cracking and seating is best suited for plain (unreinforced), jointed concrete pavements. Breaking and seating works best for reinforced pavements. Rubblization can be used with either reinforced or unreinforced pavements. The break and seat technique is favored in Kentucky because the state's PCC highways all have steel in them.

Early experience

Kentucky's first break and seat project was completed in late 1983 on I-71 in Gallatin County. Three sizes of particle breaks were tried. The size ranges were 3 to 12 inches, 18 to 24 inches and 30 to 36 inch particles. The overlay thickness was 7 inches. Being the first project, a few variables were evaluated, including the effectiveness of the breaking and seating (various rolling patterns) efforts. The stiffness of the fractured and seated layer was also back-calculated.

From this project, the initial construction specifications were developed. An 18- to 24-inch breaking pattern was chosen and rolling/seating required five passes with a 35-ton pneumatic (rubber tire) roller or three passes with a 50-ton pneumatic roller. Data was collected for developing the overlay design procedures, which followed.

From 1983 to 1986, Kentucky broke, seated and overlaid about 750 lane-miles (187.5 centerline miles) of interstate, parkway and National Highway System routes. The performance was generally very good and this rehab practice was continued. As experience was gained, some of the issues considered were:

- validating the extent of breaking or cracking
- approving acceptable breaking equipment
- determining acceptable seating/rolling patterns and
- establishing minimum asphalt overlay thicknesses.

90s experience

During the 1990s, Kentucky broke, seated and overlaid 836 lane miles of interstate pavements and 292 lanes miles of parkways. The overlay thicknesses ranged from 4.5 to 9.5 inches of asphalt. Some projects experienced areas of localized distress, which led to procedural refinements. These localized problems included:

- drainage / water problems
- variations in breaking patterns and
- overlay thickness concerns.

More recent experience

Through mid-summer of 2010, Kentucky has rehabbed more than 1,900 lane miles (or 475 center-lane miles) of concrete pavement by breaking, seating and overlaying with asphalt. The current overlay thickness designs are using 8 to 12 inches of asphalt over the fractured PCC. Kentucky continues to evaluate internal pavement drainage, variations in breaking patterns, and overlay thicknesses, including looking at perpetual pavements.

Lessons learned

As mentioned earlier, some problems with drainage, breaking patterns and overlay thicknesses were encountered. These localized issues served as the basis for refinements to the break, seat and overlay strategy.

Kentucky learned that broken and seated PCC pavements need to be treated as a free-draining aggregate base and must be drained. It was learned that the drainage outlets were being spaced too far apart and that some of the outlets were clogged from fine material generated during the breaking process. Some outlet pipes separated from the headwalls. A problem was found with guardrail posts being driven through the outlet pipe. On one project, about one half of the outlet pipes were blocked by guardrail posts. Numerous instances of blocked rodent screens were found.

It was learned that the measurement of a breaking pattern can be subjective and visual determination of breaks can lead to different interpretations. Cracks in a wetted surface show up much more than in a dry pavement. Regardless of the how the breaking pattern is monitored, it is critical that the effects of any reinforcing steel in jointed, reinforced concrete pavements must be eliminated. Eliminating slab action of the old concrete pavement is essential.

Kentucky also learned that the breaking pattern and resulting particle sizes influence the overlay thickness. Design personnel back-calculated the effective elastic modulus or stiffness of the in-place fractured concrete. Values determined in this manner were as follows:

- 3 — 6 inch pieces, 9 to 30 ksi

- 18 — 24 inch pieces, 50 to 1,000 ksi
- 30 — 36 inch pieces, 600 to 2,000 ksi.

These findings showed that the breaking pattern had a direct influence on stiffness values, and in turn, overlay thicknesses. Differences of in-place particle sizes and associated design stiffnesses, led to variations of 1.5 to 2.0 inches in overlay depths for otherwise similar conditions. In recognition of this, Kentucky adopted conservative designs.

Standardized specification

From 1982 to 1990, Kentucky had six different specifications for breaking/seating/overlays. Since 1990, only minor refinements have been made. The significant points of the current specification are:

- no more than 20 percent of the particles may be greater than 24 inches;
- no individual fragments greater than 30 inches in any dimension;
- a maximum vertical deflection of one-half inch;
- breaking is determined by visual inspection of the dry surface;
- breaking is performed by impact hammer;
- seating is accomplished by pneumatic roller (50-ton roller, 5 one-way passes; or 35-ton roller, 7 one-way passes); and
- asphalt overlay must be placed within 24 hours after breaking.

Rubblization experience

To date, KYDOH has not used rubblization extensively. It may be used selectively on a project specific basis. The limited use of rubblization is primarily due to the successes and familiarity Kentucky has with using the break and seat technique. Contractors have equipment and experience with breaking and seating.

Keys to success

The keys to Kentucky's success with using break, seat and overlay for concrete pavement rehab have been in developing a standard specification, a working drainage plan and an overlay thickness design methodology.

The specification must include provisions for equipment and techniques which ensure the elimination of slab action and de-bonding of the concrete from any reinforcing steel. Continuous monitoring and adjustment of the breaking operation must be done. Before the full breaking operation begins,

a test section is broken using varying energy and striking patterns to establish a pattern for visually acceptable breaking of the project's pavement.

The drainage plan must include a maximum outlet spacing. Kentucky requires a drainage outlet at most every 250 feet. Maintenance of the drainage system is necessary, including inspection of the drains and headwalls.

The thickness design approach must accurately account for the stiffness of the broken concrete and provide adequate overlay thickness to carry the design traffic for the intended life of the pavement.

Breaking, seating and overlay with asphalt is a major part of Kentucky's successful strategy of rehabilitating old, worn-out concrete pavements.

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