Case Study Topic: ***How does summer versus winter placement of CRCP influence its behavior?***

BACKGROUND

Cracks develop in continuously reinforced concrete pavements (CRCP) a few hours to a few days after construction due to thermal stresses. In some cases, the cracks may not be apparent for 5 or 10 years, but once they do appear they can rapidly progress into distresses that significantly affect the long-term performance of the pavement.

Excessive thermal cracking is often due to high temperature differentials, excessive subbase friction, aggregates with high coefficients of thermal expansion/contraction, or a combination of the above.

ANALYSIS STRATEGY

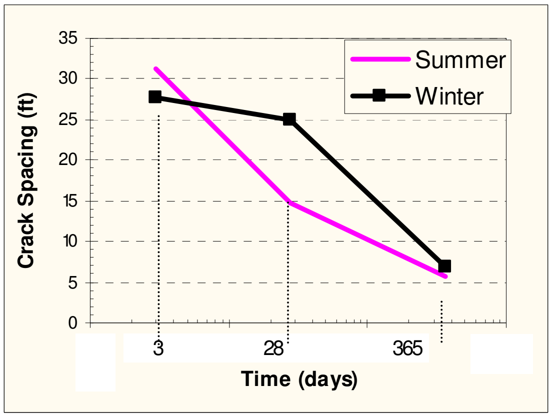
In this case study, a proactive seasonal analysis is performed on an 11" CRCP. Mary Engineer wants to see the influence of summer and winter placements on CRCP performance for a given steel design. She knows that thermal stresses play a significant role in CRCP crack development, and subsequently their long-term performance.

For guidance, she picks up the HIPERPAV II guidelines. In section IV.5.3: Climatic Inputs, there is a discussion on the effect of early-age and long-term climatic inputs on CRCP performance. She decides to perform two series of HIPERPAV runs, one for summer time placement (July 25th) and another for wintertime placement (January 2nd) using the weather estimates contained in HIPERPAV. And because of the unpredictability of actual weather conditions, she decides to adjust the post 72-hour temperatures. She lowers the minimum air temperature after the critical analysis to 33°F.

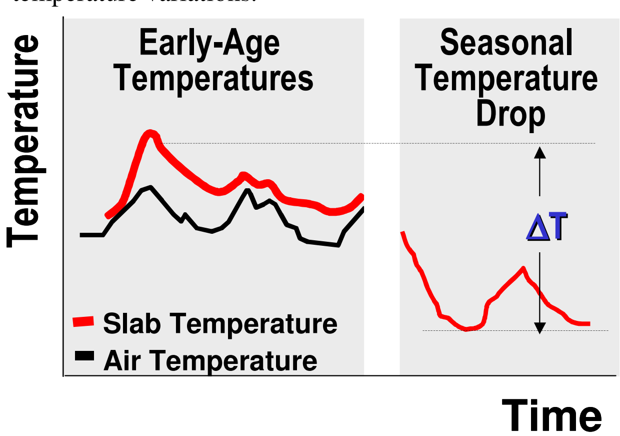
When evaluating the HIPERPAV analyses, Mary Engineer is going to examine the early-age indicators of long-term CRCP performance: crack spacing, crack width, and steel stress (IV.2.3). She knows that if the average crack spacing is less than 3.5 feet, it is likely that punchouts (shown below) will form in the CRCP, lowering its long-term performance (IV.4.7).

SOLUTION

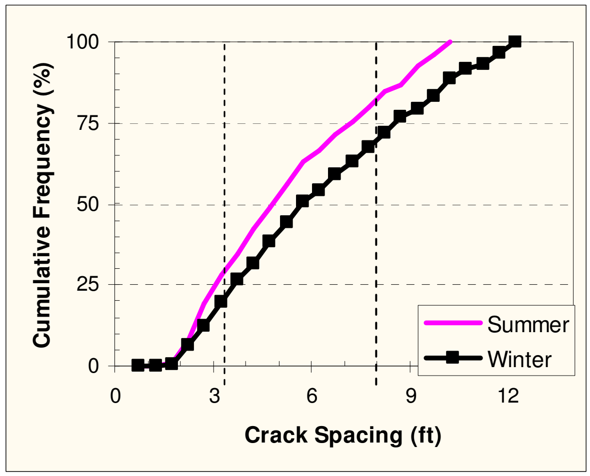
To perform her analysis, Mary modifies the post-72 hour climatic data, but keeps all other inputs at their default values. Over time, the crack spacing decreases as shown in the figure below. She finds that a winter placement yields a CRCP with a larger average crack spacing at 1 year (6.9 ft.) than a summertime one (5.7 ft.). This means that punchouts are not as likely to form when a CRCP is constructed in winter.



For both the summer and winter placements, increasing the temperature differential in the pavement (increasing ΔT) causes the crack spacing to decrease. As ΔT increases, the slab is subjected to a larger temperature change as shown in the figure below. This means that more cracks are likely to form, since cracking in concrete pavements is highly influenced by temperature variations.



HIPERPAV takes into account the thermal processes due to the concrete's heat of hydration, the curing temperature, the daily minimum temperatures and the annual minimum temperature when predicting crack formation. A cumulative frequency plot of crack spacing at one year for the summer and winter placements (with ΔT = 60ºF and 22ºF, respectively) is shown below. The trend at one year is consistent -- the CRCP placed in the summer has closer cracks.



Using this HIPERPAV analysis, Mary Engineer realizes that with proper analysis, she will be able to construct a CRCP with good long-term performance during the winter. And if a CRCP can only be placed in the summer, she can modify the construction process to improve its performance. She has other options to controlling the concrete temperature, such as improving the curing method. They can be investigated with HIPERPAV as well. HIPERPAV allows her to take the guesswork out of CRCP performance, giving her the ability to construct CRCP with consistently good long-term performance.