The Effect of Joint Sealing on the Performance of Thin Whitetopping Sections at MnROAD

Bonded concrete overlays over existing asphalt pavements, also known as "whitetopping," are becoming an increasingly popular rehabilitation solution for many agencies. As with any rehabilitation technique, it is important to understand and incorporate cost effective features that will insure long lasting performance.

Since the long term performance of thin whitetopping is reliant on a strong bond to the underlying asphalt, it is important to protect that bond for as long as possible.

The primary way to reduce bond degradation is by keeping water away from the surface of the underlying asphalt. This is typically done by filling or sealing the contraction and panel edge joints with liquid ("hot-pour") asphalt sealant. Due to the thin slab designs typically used for whitetoppings, panel sizes need to be smaller, thereby resulting in many more joints than in typical concrete pavements. With today's restricted budgets, owners and engineers must consider whether the sealing or filling of joints in whitetopping provides an economic benefit.

NEED FOR SEALING

Most whitetopping projects consist of removing a portion of the existing asphalt pavement, in order to maintain the original profile grade. This is commonly accomplished using a milling machine, which both removes the distressed asphalt surface layers, as well as provides a rough interface that improves bonding with the concrete overlay. At the same time, the removal process also creates a classic "bathtub" situation, were the whitetopping joints become reservoirs for water to accumulate. See Figure 1.

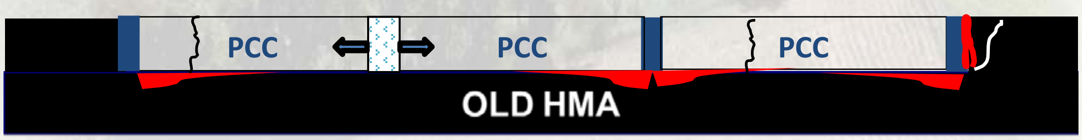

Figure 1. Water in joints can lead to reduced layer bonding, erosion, cracking, and panel shifting (ice expansion)

To determine the benefits of sealing joints in whitetopping overlays, several test sections were constructed in 2004 at the Minnesota Road Research (MnROAD) facility. After more than seven years of interstate traffic and exposure to the extreme climate of Minnesota, sufficient data now exists that can answer the question of whether sealing or filling thin whitetopping joints has a significant effect on long term whitetopping performance.

TEST SECTIONS

Four whitetopping test sections were constructed at the MnROAD facility in 2004. Test cells 60 and 62 were constructed with single saw-cut joints filled with hot-pour asphalt sealant. Test cells 61 and 63 were identical in design, except the joints were not sealed. Panel size for all cells was 5 feet long by 6 feet wide [1.52m L x 1.83m W]. Cross-sections of the test cells are depicted in Figure 2.

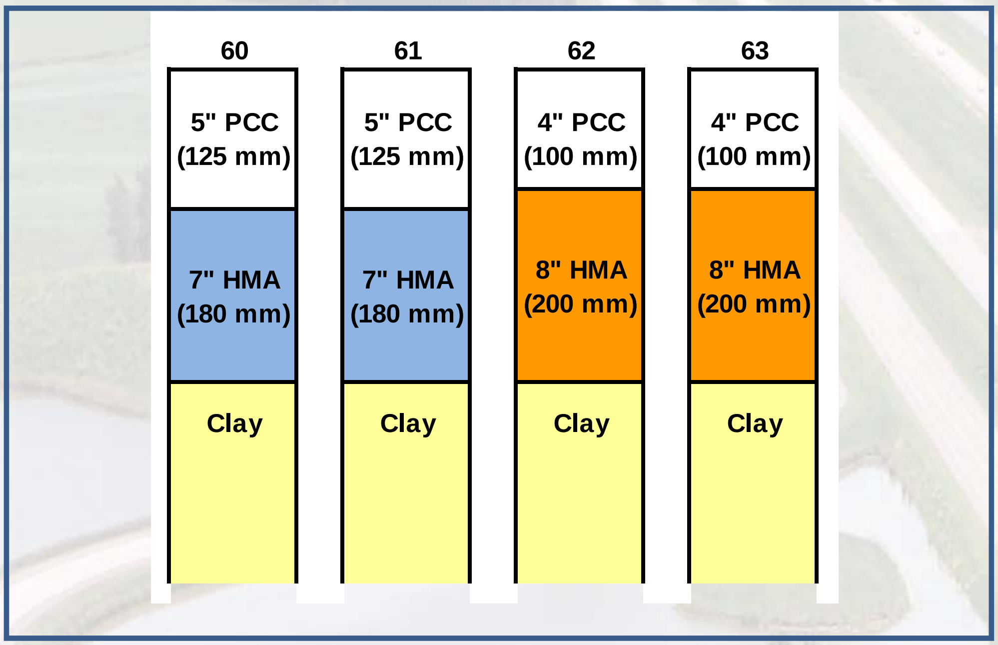

Figure 2. Design details for MnROAD whitetopping test cells 60-63.

PERFORMANCE

Since 2004, MnROAD test cells 60-63 have experienced over 6.5 million ESALs (Equivalent Single Axle Loads) from live interstate traffic. This can be classified as an accelerated rate of loading for such thin designs that would more commonly be built on lower volume roads.

Throughout their lives, the test cells were monitored closely for distress and serviceability. By fall 2010, the 5 inch thick cells 60 and 61 had 11% and 8% of their panels cracked, respectively. Interestingly though, for the 4 inch thick cells, the unsealed cell 63 had 55% of its panels cracked, compared to 11% for cell 62 with the sealed joints. Not only was there more cracked panels in cell 63, but degree and type of cracking was different. Figure 3 shows a typical "shattered" panel from cell 63, while Figure 4 shows the increasing rate at which the panels were deteriorating. In order to keep the test section in service, the joints and edges of cell 63 were sealed with methyl-methacrylate and hot-pour sealant in Fall 2010. Sealing of the joints and edges did seem to slow the rate of crack development in the panels before full panel replacement repairs were performed during the summer of 2011.

Figure 3. Cracked and "shattered" panels in Cell 63 (Fall 2010).

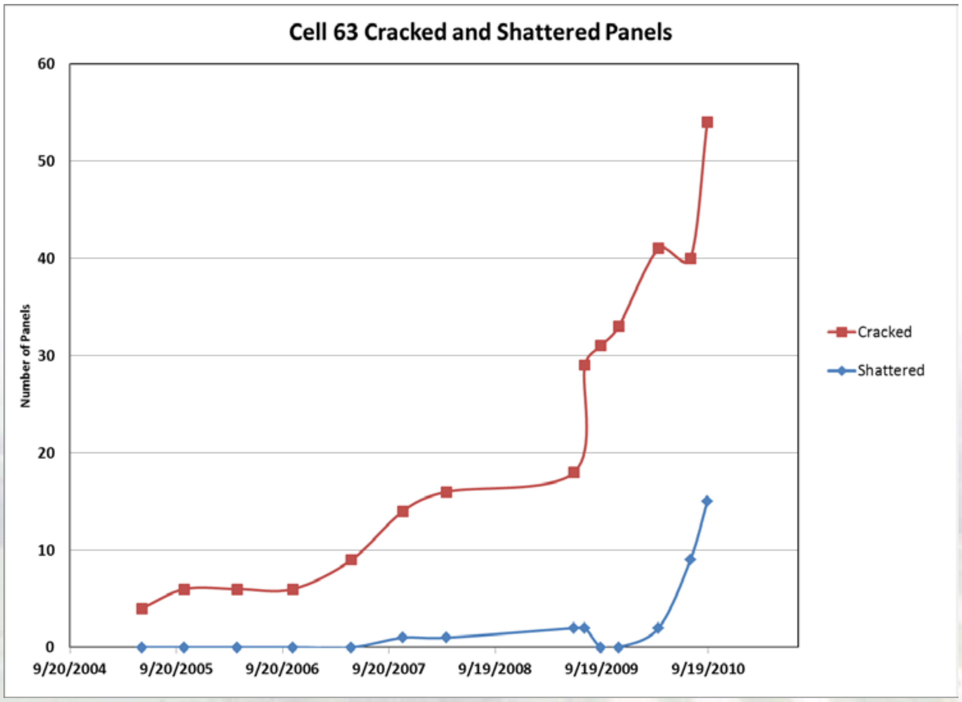

Figure 4. Development of cracking distress in Cell 63.

Core samples extracted in 2010 from each of the cells revealed that even though joints were sealed/filled in cells 60 and 62, the underlying asphalt was debonding near the joints. This demonstrates that while joints can be sealed/filled near the surface, water will find its way into joints and eventually begin to degrade the asphalt. The greater number of surface cracks formed in the unsealed cells however, results in an increased rate of panel deterioration as the cracks allow additional water to reach the concrete/asphalt interface.

One other observation noted in not only the whitetopping cells, but other unsealed/unfilled single saw-cut joints in other MnROAD cells, is the increased amount of spalling and widening of the joints. Widening of the joints could be explained by the expansion forces from water freezing within the joints. Causes for the increased amount of spalling along joints have yet to be determined.

COST BENEFICIAL?

While the MnROAD test cells 60-63 have demonstrated the potential effects of sealing or filling whitetopping joints, there still lies the question of whether it is cost beneficial. Whitetoppings tend have smaller panels, which therefore result in many more joints to seal/fill.

Many whitetopping paving plans and contracts list sealing/filling of joints as incidental to the joint forming bid item. Therefore historical cost information is not readily available. It is, nevertheless, informative to examine the material costs of sealing/filling alone. The material costs for the hot-pour asphalt sealant in cell 60 was estimated to be (in 2011 dollars) $2600 per mile. It would be an agency's decision on whether this is determined to be cost beneficial to a particular project. Given that the thicker cells 60 and 61 experienced a similar number of panel cracked as the sealed cell 62, there may be some minimum overlay thickness after which sealed/filled joints may not have as significant effect on lifespan. Additional monitoring and research will be needed to determine such minimum thicknesses.

CONCLUSIONS AND RECOMMENDATIONS

Several test sections at the MnROAD facility have demonstrated a noticeable difference in performance between sealed/filled and unsealed/unfilled joints. While the difference in the number of cracked panels was similar once the overlay thickness was greater than 5 inches, all of the sections showed signs of a deteriorating bond between the layers. Other test sections at MnROAD with single saw-cut unsealed/unfilled joints have also shown increased spalling compared to sealed/filled joints.

As with any pavement structure, the management of water within the system is critical. Water is a destructive medium that must either be kept out, or drained through efficiently. Standing water in thin whitetopping joints is destructive to the very important bond that is necessary to achieve long term performance. The sealing/filling of whitetopping joints can be likened to a low-cost insurance policy for your pavement.

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