HIGHLIGHTER

EVALUATE DENSIFIER-OVER-SHOTBLASTING (DOS) TREATMENT PERFORMANCE FOR PAVEMENTS AND BRIDGE DECKS

May 2017

PROJECT TITLE
EVALUATE DENSIFIER-OVER-SHOTBLASTING (DOS) TREATMENT PERFORMANCE FOR PAVEMENTS AND BRIDGE DECKS

FINAL REPORT ~
FHWA-OK-16-02
ODOT SP&R 2258

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OVERVIEW With increased demands on our aging infrastructure, rapidly increasing truck traffic, and shrinking budgets, transportation agencies are continually being asked to "do more with less" in maintaining pavements and bridges. This research investigated a method for combining chemical treatment (lithium silicate densifier) and shotblasting, called densifier-over-shotblasting (DOS), to economically harden the aggregates of concrete and asphalt pavements and bridge decks. The DOS method can be added to the pavement preservation toolbox to make surfaces safer and more durable, reduce maintenance costs and increase the service life of pavements and bridge decks.

RESULTS This study (1) evaluated and measured the DOS treatment's ability to inhibit polishing and abrasion through the chemical hardening of aggregate (laboratory phase), (2) evaluated and measured the extent to which DOS inhibits microtexture deterioration of road surfaces (field testing phase) and (3) developed specifications, design methodology, and construction methods necessary to transfer this technology to practice.

The DOS technique aims to harden the aggregate surface through a combination of chemical (lithium silicate densifier) and mechanical (shotblasting) processes. A harder surface inhibits aggregate abrasion and polishing, allowing the pavement to maintain a greater level of skid resistance and enhance driver safety for a longer period of time. Figure 1 shows a laser image of the surface texture of a DOS-treated concrete pavement.

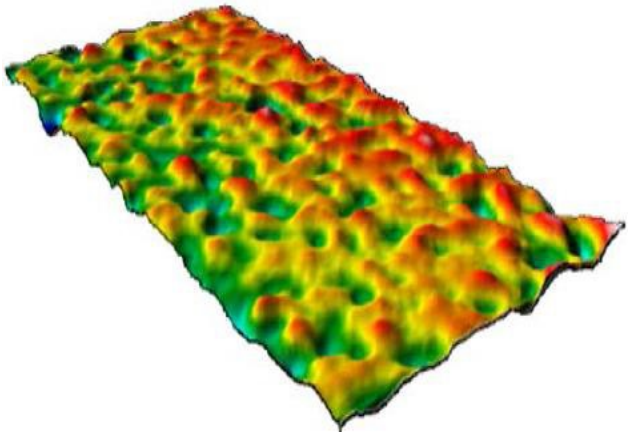

Figure 1 Laser Image of DOS-Treated Surface

Four aggregate properties influence pavement surface texture (skid resistance): toughness, polish resistance, angularity and soundness. In this study, six types of Oklahoma aggregates were treated with the chemical hardener and tested. LA Abrasion and Micro-Deval were tests used to indicate aggregate durability, British Pendulum was used to indicate aggregate polishing, an aggregate imaging system (AIMS) was used to indicate angularity, texture, shape and polishing, and the sodium sulfate test was used to determine aggregate soundness. Results showed that the DOS treatment helps the aggregate retain its angularity and texture under polish-wear conditions, which enhances skid resistance and inhibits polishing.

Microtexture and macrotexture are important indicators of pavement and bridge deck surface friction. The National Center for Asphalt Technology (NCAT) conducted

accelerated polishing testing on DOS-treated hot mix asphalt samples in its laboratory. NCAT used the dynamic friction tester (DFT) to provide results for microtexture and the circular track meter (CTM) to provide results for macrotexture. One way to combine and report both measurements is to use the International Friction Index (IFI). After a period of accelerated polish-wear conditions, the DOS-treated samples showed greater performance in terms of friction than the control, as shown in Figure 2.

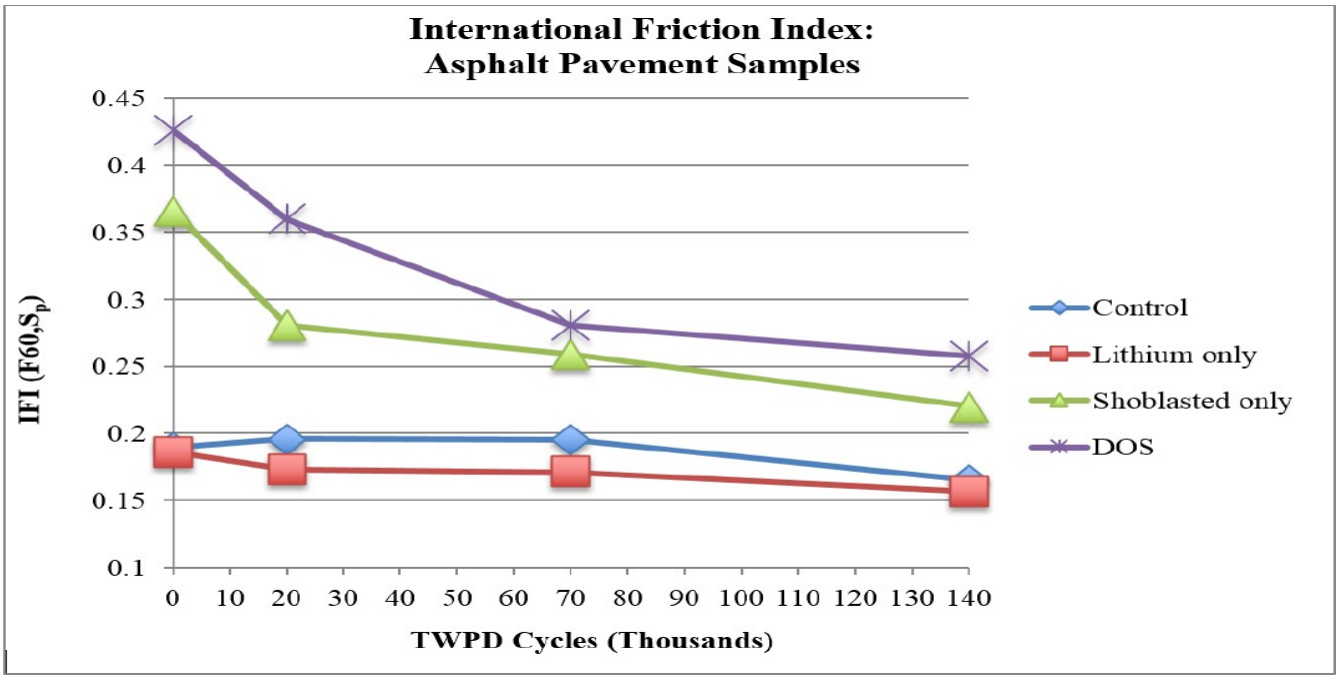

Figure 2 Indicator of HMA Skid Resistance as Quantified by the International Friction Index

Field test sections, including asphalt and concrete pavements and bridge decks, were established, DOS-treated and measured for microtexture and macrotexture over the period of one year. The general trend in the field testing results was that the DOS-treated sections outperformed untreated sections. This was consistent with the trend in the laboratory data, although the aggregate sources used in the field test sections were unknown.

To gain insight regarding the economic viability and environmental performance of DOS, a deterministic life cycle cost analysis (LCCA) and a life cycle assessment (LCA) were conducted considering four surface treatments: 1-inch asphalt (HMA), shotblasting, microsurfacing and DOS. DOS was found to have a higher initial cost; however, the results of the LCCA indicate that it has a comparable life cycle cost related to the other surface treatments. The sensitivity analysis revealed that there was no sensitivity with regard to expected service life and discount rate in this case, as the rank order remains the same for the treatments. However, in practice, these factors, along with commodity volatility, could greatly impact the output. HMA and microsurfacing prices are driven by the volatile crude oil market, and therefore, DOS and shotblasting may yield lower initial and life cycle costs when asphalt binder prices rise. The results of the LCA indicate that the DOS technique exhibits better environmental performance than the other treatments on a life cycle basis because it consumes the smallest amount of annualized energy and emits the least amount of annualized greenhouse gases of the pavement treatments analyzed. The multi-attribute analysis, which involved various weighting scenarios for combining cost and environmental impacts, demonstrated that DOS is an economically and environmentally competitive treatment.

POTENTIAL BENEFITS The resultant benefits of this study should enhance safety due to maintained surface friction, regardless of season. Benefits also include extending average pavement/bridge deck service life by quantifying the aggregate characteristics that slow surface deterioration as determined by field performance evaluation and laboratory aggregate analysis. Achieving these benefits provides a further benefit of releasing scarce maintenance funds to be used as programmed by reducing the amount of unplanned reactive maintenance that occurs on a statewide basis.