



TECHNICAL SUMMARY

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LRRB PROJECT COST:
\$40,000



Researchers took core samples of city streets for air void and permeability testing in the laboratory.



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

Preventing Stripping of Asphalt Pavements under Chip Seals

What Was the Need?

With the high cost of hot mix asphalt, MnDOT and local agencies make use of low-cost preventive maintenance techniques to prolong the life of roads. One method for surface sealing asphalt pavements is chip sealing, in which the existing pavement surface is covered with an asphalt emulsion and layer of aggregate.

However, for many years Minnesota agencies have had a problem with deterioration of the pavement layer ½ inch to 1 inch underneath chip seals, usually on urban curb-and-gutter streets. Called stripping, this distress begins as a small blister and enlarges to the size of a pothole, causing the HMA to deteriorate. This area of deterioration can expand and can become an expensive maintenance problem.

What Was Our Goal?

The objectives of this project were to determine the cause of pavement stripping after chip sealing, the characteristics of pavements that tend to exhibit this problem and methods for preventing stripping.

What Did We Do?

MnDOT researchers began by conducting a survey of Minnesota cities and counties to determine the extent of stripping under chip seals in the state. Then they evaluated various laboratory tests for use in determining the causes of stripping. They conducted air void and permeability testing on samples made from an asphalt mixture that had proven resistant to stripping and which had been compacted to contain 7, 10 and 14 percent air voids.

Air voids, measured as a percentage of solid material, are an indication of a specimen's permeability and density. Permeability is a measure of the ease with which water can pass through a specimen and can also be an indication of density. Compacting pavements to the right density—typically 7 percent air voids—is important to prevent oxidation and moisture damage that can lead to stripping.

After testing laboratory samples, researchers conducted similar testing on core samples taken from city streets experiencing stripping. They also developed field test requirements for using a field permeameter and nuclear density gauge—which determines density by measuring reflected radiation—to evaluate whether a street is a good candidate for a chip seal and will be less likely to strip.

Finally, researchers reviewed city construction methods, compared them to MnDOT's standard specifications and developed recommendations for improving these methods.

What Did We Learn?

Of 66 survey respondents, more than 40 said their agency was experiencing stripping under chip seals. Interviews with selected respondents suggested that streets suffering from stripping issues had variable densities, with areas close to stripping having moisture under the pavement, higher permeability and higher air void content. Researchers

The recommendations developed in this project will help agencies prevent and remedy stripping under chip seals, which can be an expensive maintenance problem for urban curb-and-gutter streets.

“The project was much needed to give maintenance personnel the tools to prevent stripping under chip seals and remedy current problems.”

—Tom Tesch,
Streets Maintenance
Manager, City of Eden
Prairie

“While there are many factors involved in stripping under chip seals, a combination of moisture, permeability and density are necessary for stripping to start.”

—Thomas Wood,
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Stripping tends to occur under chip seals of urban curb-and-gutter streets because their closed structure traps water, which can damage asphalt where density is low. Results showed that using a more breathable fog seal instead of a heavier chip seal may help alleviate this problem.

hypothesized that this was caused by inadequate compaction, allowing water to permeate the asphalt and cause it to strip.

Both laboratory and field results confirmed this hypothesis, with stripping increasing as permeability increased. On city streets, areas close to stripping streets had a high variability in density, ranging from 7 to 12 percent air voids.

Researchers found the nuclear density gauge to be the easiest field method for checking variability in density. When using this method on city streets, researchers found a large variation in mix weight per cubic foot between areas with and without stripping—from 117.3 to 145 pounds per cubic foot on one street. Researchers recommend not using chip sealing on a street if the variability in density is greater than 6 pounds per cubic foot.

In a review of construction methods used by cities, researchers found that cities were using ordinary compaction methods, which should yield a good pavement density when executed properly. However, ensuring that all areas of a pavement receive a proper number of rolling passes at the proper temperature can be difficult when streets have variable widths and curves. Researchers suggested that localities follow MnDOT recommendations for taking core samples randomly from pavements to verify that proper density has been achieved.

Results also showed that alternative use of a lighter fog seal could help alleviate stripping by stopping water infiltration while allowing water vapor to escape.

What's Next?

Researchers recommended that MnDOT incorporate data about density variability into its bituminous training classes to help ensure better construction methods, and they developed a handout to inform agencies about preventing stripping under chip seals. They also suggested further research into optimizing mix designs and paving practices for residential streets.

This Technical Summary pertains to LRRB-produced Report 2013-08, “Stripping of Hot-Mix Asphalt Pavements under Chip Seals,” published April 2013. The full report can be accessed at <http://www.lrrb.org/PDF/201308.pdf>.