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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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LRRB PROJECT COST:
$140,508

Researchers identified partial stripping of the seal coat on this asphalt pavement.

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

Investigating Asphalt Pavement Stripping Under Seal Coats

What Was the Need?

Local agencies often use seal coats to extend the life of asphalt pavements, improve the ride and enhance pavement resistance to moisture. This practice can buy several extra years of service before an asphalt pavement is fully rehabilitated or replaced.

Also called a chip seal, a seal coat entails a thin layer of sprayed asphalt material or emulsion, followed by a layer of up to 3/8-inch aggregate chips that are then rolled in and partially embedded in the seal so that the resulting seal coat will only be one-stone thick.

Many cities and counties use seal coats without problems. Some, however, report delamination (or peeling away) of the chip seal, exposing the underlying asphalt to damage and creating a rough ride for drivers. Separation of seal coats from underlying structures is thought to be a result of moisture penetration following freeze-thaw activity.

In years past, pavement improvement approaches anticipated a single freeze-thaw cycle every year. But today, many Minnesota areas experience multiple freeze-thaw cycles every winter, as temperatures rise and fall above and below freezing several times throughout the season. Delamination of seal coats may result.

Research confirmed that freeze-thaw activity leads to delamination of seal coats from underlying pavements. Multiple cycles increase damage. Investigators identified optimal seal coat mix combinations and site conditions that may ensure effective seal coating of asphalt pavements in cities and counties around Minnesota.

What Was Our Goal?

In this Local Road Research Board (LRRB) study, researchers examined seal coat use in Minnesota, investigating delamination problems and determining what conditions may contribute to the likelihood of this failure. Study results would help local agencies determine how useful seal coats might be on their road systems.

What Did We Do?

In late 2017 and late 2018, researchers visited eight Minnesota city and county locations to gather field information for seal coat evaluation. The team collected data to help diagnose premature stripping, including information on the service condition of pavements, mix designs beneath seal coats, material used in chip seals and the extent of stripping.

LRRB and MnDOT provided 48 8-inch cores from the sites for laboratory testing, which focused on bond strength in terms of shear and interface bond, as well as asphalt loss, at different temperatures and moisture levels, and over multiple freeze-thaw cycles. Cores were sorted according to degrees of damage; seal coat material; and pavement age (under five years, five to eight years and eight to 15 years). Aggregate chips and emulsions were also collected. From these materials researchers prepared almost 300 lab samples for bond testing.

Based on a literature review, field surveys and bond testing, researchers developed recommendations for the use of seal coats on Minnesota roadways.

What Did We Learn?

Researchers were unable to declare seal coats productive or counterproductive in sweeping terms.

Bond strength at the interface of the seal coat and pavement decreased with increases in freeze-

continued

"This solidified some of our suspicions. Increases in freeze-thaw cycles exacerbate or accelerate the delamination and the stripping that we have seen. That top bond gets weaker through repeated cycles."

—Steven Bot,
Public Works Director,
City of St. Michael

"With chip seal projects, high-quality data will be really important. We should know what kind of emulsion we used, what kind of aggregate and underlying pavement mix design we used."

—Zhanping You,
Professor, Michigan Technological University Department of Civil and Environmental Engineering

Investigators at Michigan Technological University developed new bond tests to determine the impact of freeze-thaw activity, temperature and moisture on pavement samples.

thaw cycles due to microstructural damage likely caused by ice expansion in voids. The research team identified a certain granite aggregate and polymer-modified asphalt emulsion as optimal seal coating for low-temperature resistance, and a small range of aggregate types and emulsion application rates in seal coating for resistance to freeze-thaw activity.

Weak aggregate and asphalt mixtures in seal coats and increased freeze-thaw cycles account for most premature stripping of chip seals. Underlying pavement may also offer some bond strength at the interface and may be damaged from multiple freeze-thaw cycles. Such seasonal wear can strip asphalt material from aggregate in the asphalt pavement just as it strips asphalt binder from seal coat chips. Lab tests also indicated that partial damage to seal coats leads to accelerated deterioration of pavements.

Two approaches to seal coating can improve freeze-thaw resistance in the seal. First, precoating aggregate with binder before application, either at the plant or in the field immediately before use, may be effective. Second, tighter quality control of asphalt emulsions and asphalt mixtures with a keener eye toward aggregate characteristics, pH levels of aggregate and binder, and other details may ensure stronger bonds between coats and asphalt pavement.

Locations that have well-draining subgrades can be expected to benefit most from seal coat use, which can last 15 years or more with little material loss in the right location. In most areas, a service life of six to eight years will be considered a good outcome; a shorter life may suggest a need for different strategies.

What's Next?

Results suggest seal coats be used deliberately, with care given to site and material selection. Further study could increase the number of evaluated cores, particularly from sites with extensive available historical mixture information. Research could also address cost-effectiveness and life cycle costs associated with seal coating.

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