Effective Use of Chip Seals in Minnesota

MELISSA K. COLE AND THOMAS J. WOOD

Cole is Research Project Engineer and Wood is Research Project Supervisor, Office of Materials and Road Research, Physical Research Section, Minnesota Department of Transportation, Maplewood.

For many years, the Minnesota Department of Transportation (DOT) has applied chip seals to preserve asphalt pavements. Long-term data show that the successful application of chip seals has extended the service life of the state's asphalt pavements an average of 6 years.

Problem

In the early 1990s, chip seal use throughout Minnesota declined to an historic low. State and local agencies were not obtaining a consistent quality of performance from the technique. Failures included bleeding—an excess of emulsion—which can cause skidding; loss of aggregate; and a general lack of long-term performance. In addition, loose aggregate was causing vehicle damage.

Research Approach and Solution

Minnesota DOT and the Minnesota Local Road Research Board (LRRB) developed a research-and-implementation project to improve chip seal performance and increase the service life of asphalt pavements.

In the early 1990s, LRRB funded a study by the Minnesota DOT Office of Materials and Road Research on state, national, and international chip seal design methods and best construction practices (*1*). The first phase of the project surveyed all agencies in Minnesota. Results indicated that the lack of a documented, rational design method was a major concern. Chip sealing practice was more an art than an engineered system.

The subsequent literature review evaluated national and international best practices and identified a chip seal design method that with slight modification would be best for Minnesota DOT use (*2*). Developed by Norman McLeod in 1969, the procedure determines the aggregate application rate according to the aggregate gradation, shape, and specific gravity. The binder application rate also depends on the aggregate characteristics, as well as on the traffic volume, the pavement condition, and the binder's residual asphalt content.

The McLeod method prescribes a chip seal that is one stone thick, with a 50 percent to 55 percent initial embedment of the aggregate layer in the asphalt binder. Minnesota DOT's modifications to the method have targeted an initial embedment of 65 percent to 70 percent, to accommodate the state's climate and to minimize damage from snowplows.

Field visits evaluated the performance of various projects. With information from the field visits and from other agencies and the industry, Minnesota DOT researchers recommended a design procedure and construction requirements.

Implementation

The *Minnesota Seal Coat Handbook*, developed in 1998, serves as a practical tool for designers and field technicians. A 2006 revision added guidance on fog

Fog sealing of a chip seal placed on state road.

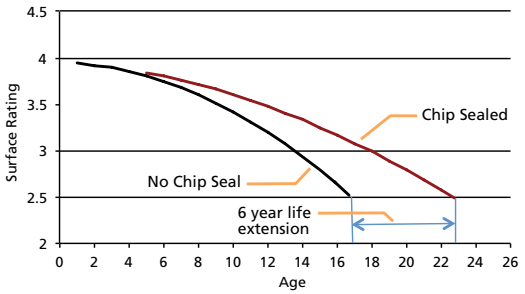

FIGURE 1 New bituminous construction in Minnesota, 1987–2007: surface rating comparison based on network averages (*1*).

sealing and on chip sealing on recreation trails, as well as a section of frequently asked questions (*3*). The primary purpose of the handbook is to provide practical information about seal coat materials, equipment, design, and construction practices for the field inspector.

Education plays a significant role in implementation. Minnesota DOT conducts formal training through the Minnesota Local Technical Assistance Program (LTAP), as well as informal training. The success of local classes has led the National Center for Pavement Preservation and the LTAPs of several states to use Minnesota DOT's chip seal class as part of their training. Minnesota DOT also offers field support to state and local agencies to enhance project delivery and the training of agency and contractor personnel.

Minnesota DOT recommends the placement of chip seals before any deterioration in the pavement is noticeable. The age of the pavements when the first chip seal is placed varies according to the traffic levels, environmental conditions, and the quality of the asphalt.

Before 2007, the average age of a bituminous pavement at placement of the first chip seal was 5 years. More recent experience, however, suggests that the optimal time to apply chip seals may be closer to the construction of the bituminous pavement. An ongoing pooled-fund study is investigating the optimal time to apply treatments such as fog seals and chip seals to optimize pavement life and life-cycle costs (*4*).

Improving Chip Seal Success

New specifications for chip seals from Minnesota DOT include the following:

- No more than 1 percent of aggregates passing the No. 200 sieve;
- Aggregate shape guidelines based on the flakiness index (Federal Lands Highway Procedure T508-96);
- A minimum of 80 percent of the aggregates single-faced crushed;
- Use of polymer-modified emulsions;
- Application of a fog seal after placement of the chip seal;
- The season for installing chip seals ends on August 31; and
- Contracts revised to pay for asphalt binder by the gallon and for aggregate chips by the square yard, so that contractors can benefit from applying the correct quantities.

Benefits

During the mid-1990s, 5 to 7 years was the normal life expectancy of a chip seal in Minnesota. In contrast, recent experience suggests a service life of 12 to 15 years or more before a new chip seal or other maintenance activity must be performed.

Successful chip sealing has increased asphalt pavement life. Data from Minnesota DOT's Pavement Management office show that for all bituminous roads during the span of 1987 to 2007, those that received regular chip seals had a service life averaging 6 years longer than that of pavements that did not receive regular chip seals (Figure 1, above left).

Chip seals offer additional benefits, such as improved safety from increased friction; improved roadway aesthetics with a more uniform pavement surface and small imperfections such as popouts filled in; and protection of the structural integrity of the underlying bituminous pavement.

Minnesota DOT is continuing research into best practices for pavement preservation. For background and updates on chip seals and pavement preservation in Minnesota, visit www.dot.state.mn.us/materials/pavementpreservation.html.

For more information, contact Melissa K. Cole, Research Project Engineer, Minnesota Department of Transportation, 1400 Gervais Avenue, Maplewood, MN 55109; Melissa.cole@state.mn.us.

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Of related interest: NCHRP Report 680, *Manual for Emulsion-Based Chip Seals for Pavement Preservation*, examines chip seal performance, design, construction, materials selection, and test methods (www.trb.org/main/blurbs/164090.aspx).

Suggestions for Research Pays Off topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).