

Chip Seals

1. Scope

The intent of this guideline is to aid in the design, testing, quality control, measurement and payment procedures for the application of a chip seal.

2. Description

This work consists of the surface preparation and application of asphalt chip seals, including single, double chip seals and shoulder chip seals. Chip seal is a pavement preservation treatment designed to extend the life of the road by sealing fine cracks, preventing water infiltration and oxidation of the pavement, while enhancing skid resistance.

3. Materials

Consult with suppliers and/or contractors for material best practices.

4. Construction

A. Equipment. Provide equipment capable of producing and placing a product meeting the requirements of this section.

- 1. Pressure Distributor.** Provide a pressure distributor with a computerized application rate and speed control, capable of maintaining the asphalt emulsion at the temperature required by the contract. Ensure that the control has a ground-sensing device that controls the application rate regardless of ground speed and spray bar width. Ensure that the spray bar nozzles produce a uniform, triple-lap application fan spray, with instantaneous shut-off and no dripping. Ensure that each pressure distributor can maintain the required application rate within ± 0.015 gallons per square yard.
- 2. Chip Spreader.** Provide a self-propelled chip spreader equipped with a computerized spread control, pneumatic tires, and a screen to remove oversized material.
- 3. Compacting Equipment.** Provide self-propelled pneumatic-tired rollers, each weighing at least 8 tons.
 - 1 Roller (0-10,000 yards/day)
 - 2 Rollers (10,001-35,000 yards/day)
 - 3 Rollers (35,001 or More yards/day)
- 4. Brooms.** Provide motorized brooming equipment, capable of cleaning the road surface before treatment and removing loose particles after treatment. Provide pick-up sweepers to clean roadways with curbs and gutters.

5. Pilot Car. Provide a pilot car equipped with a sign that reads “Pilot Car — Follow Me” in accordance with MDOT Sign Standard G20-4. Mount the sign in a conspicuous position on the rear of the vehicle.

- Two lane flag control with ADT of 3,000 cars a day or speeds above 45MPH
- Low volume traffic with low speeds already in place

6. Lights on Equipment. Equip self-propelled equipment with at least one approved, flashing, rotating, or oscillating amber light, visible in every direction. Equip chip spreaders with one light on each side of the spreader.

B. Pre-Production Meeting. Before beginning work, conduct pre-production meeting with the agency/owner representative to discuss the following:

1. Review of the work schedule
2. Examination of the traffic control plan
3. Review of equipment calibration and adjustments
4. Inspection of conditions of materials and equipment, including transport units
5. Discussion of the QC plan; and
6. Designation of the contractor’s authorized representative

C. Calibration. Calibration of the equipment is necessary for proper application rates of emulsified asphalt and aggregate. Upon request, the contractor may provide documentation verifying machine calibration. A yield check should be conducted periodically.

1. Asphalt Distributor. The asphalt distributor applies asphalt to the pavement surface. ASTM D-2995 “Estimating Application Rate of Bituminous Distributors” is considered acceptable to calibrate the distributor in most parts of the United States. An exception to uniform nozzle size across the spray bar is allowed when lower application rates are desired in the wheel paths. In this case, smaller nozzles are inserted in the spray bar.

2. Nozzle Angle. The next step in calibrating the asphalt distributor is adjusting the spray bar nozzle angles. When the nozzle is threaded into the spray bar, the slot should be positioned at an angle of 15 to 30 degrees to the axis of the spray bar. The end nozzles of the spray bar may be positioned differently.

3. Spray Bar Height. The next step in calibrating the asphalt distributor is adjustment of the spray bar height to obtain a uniform, even application of asphalt. This adjustment process is accomplished by shutting off nozzles to determine where the spray pattern contacts the pavement. Every other nozzle should be turned off for a double lap application and two nozzles should be turned off for every one that is left on for a triple lap application.

The asphalt distributor operator should spray emulsified asphalt onto the pavement surface for as short an interval as possible while an observer watches where the emulsified asphalt hits the pavement from each nozzle left open. If the emulsified asphalt overlaps for a double lap application, the bar is too high. If there is a gap between the emulsified asphalt applications, the bar is too low.

- 4. Longitudinal Flow Rate.** Longitudinal calibration of the asphalt distributors is best accomplished by measuring the volume of the asphalt distributor before and after spraying a 1,000' segment.

First, the quantity of emulsified asphalt in the truck must be determined. Measure with the dip stick. Record this volume as 'beginning volume'. Set up the truck and initialize the asphalt distributor's computer (if equipped) and record the initial reading. Then spray the emulsified asphalt for the 1,000' segment. Upon completion of the spraying, take a final computer reading and a second dip stick reading. Record this second dip stick reading as 'ending volume'. Then subtract 'ending volume' from 'beginning volume' and record this as 'volume used'.

Determine the area of emulsified asphalt sprayed and divide the 'volume used' by the area sprayed in square yards. This is the gallons per square yard applied to the pavement. This value should then be compared to the asphalt distributor's computer final volume reading to evaluate the accuracy of the computer. A correction factor may then be applied to the computer output, if needed, and used for the remainder of the day.

This calibration should be accomplished each day. An example of this calibration is presented below:

Given:

1800-gallon capacity asphalt distributor
12-foot spray width
Trial spray distance = 1,000 feet
0.39 gallon/yd² design spray rate
Dipstick reading beginning of spray = 1,765 gallons
Dipstick reading end of spray = 1,245 gallons

Calculations:

Check to see if enough volume sprayed. $1,765 - 1,245 = 520$ gallons
Calculate spray rate = $520 \text{ gallons} / (12 \times 1000/9) = 0.39 \text{ gallons/yd}^2$

Should a result different than design and or computer setting occur decrease asphalt distributor speed or recalibrate computer and re-check.

- 5. Aggregate Spreader Calibration.** Various methods of calibrating this equipment have been used and the ASTM D 5624 procedure can be effective. Compensation for moisture on the aggregate may be necessary when calibrating aggregate spreaders.

- a. Longitudinal Spread Rate.** The aggregate application rate should be very similar to the design application rate. This is a rate where immediately upon dropping the aggregate a significant amount of asphalt should be visible. If no asphalt is visible, there is an excess of aggregate, and the rate should be reduced.

It's important to evaluate the amount of aggregate placed by the chip spreader after the rate is established. This is best accomplished using ASTM D 5624. If the ASTM method is not practical, a suitable alternative includes placing a tarp over 1 square yard of pavement or ground, applying coarse aggregate in a production run, retrieving the aggregate placed on the tarp and weighing the coarse aggregate retrieved.

If scales are present at the project stockpile station a suitable alternative includes calculating the quantity of aggregate placed over a known area. An example follows:

Given:

Trucks loading the aggregate spreader are 12-ton capacity tandem dumps
12-foot wide pavement
28 pounds per square yard design spread rate

Calculations:

1. Check Truck No. 1
 - a. Load = 23,803 lbs
 - b. Spreader distance = 640 feet
 - c. Rate = $23,803 / 640 \times 12 / 9 = 27.9 \text{ lbs/yd}^2$
2. Check Truck No. 2
 - a. Load = 23,921 lbs
 - b. Spreader distance = 634 feet
 - c. Rate = $23,921 / 634 \times 12 / 9 = 28.3 \text{ lbs/yd}^2$
3. Check Truck No. 3
 - a. Load = 23,848 lbs
 - b. Spreader distance = 639 feet
 - c. Rate = $23,848 / 639 \times 12 / 9 = 28.0 \text{ lbs/yd}^2$

4. Average Rate = $(27.9 + 28.3 + 28.0) / 9 = 28.1 \text{ lbs/yd}^2$

5. Should a result different than design of more than 1 percent of design make adjustments and perform another calibration check.

D. Surface Preparation

1. **Protecting Utility Castings and Raised Pavement Markers.** Before beginning the chip seal operation, protect utility castings and raised pavement markers using other protective coverings approved by the agency/owner. Remove the protective coverings before sweeping and opening to traffic.
2. **Preparing Pavement Surface.** Prepare the pavement surface to receive the chip seal. Remove cold plastic pavement markings using an abrasion method. Clean pavements requiring treatment with a motorized power broom to remove loose material. Use a hand broom to clean cracks and other areas inaccessible by power broom. Use pick-up sweepers on roadways with curbs and gutters.

E. Construction Operations

1. **Equipment Operation.** Operate vehicles and equipment involved in the chip seal operation as closely together as practicable.
2. **Dust Control.** Optional based on conditions. During normal traffic operations, wet broom, or lightly fog seal the roadway to control dust, as required by the agency/owner.
3. **Bleeding or Flushing.** Sanding the roadway to eliminate bleeding or moderate flushing is acceptable.
4. **Longitudinal Construction Joints in Single Chip Seal.** Construct longitudinal construction joints in single chip seal to coincide with painted lane lines or at the outside edge of the shoulder.
5. **Longitudinal Construction Joints in Double Chip Seal.** Construct longitudinal construction joints in the first course of a double chip seal to overlap the painted lane lines by 6 inches, and in the second course to coincide with the original painted lane line locations.
6. **Longitudinal Construction Joints in Shoulder Chip Seal.** Construct the longitudinal construction joint in shoulder chip seal at the edge of the driving lane or at a location requiring minimal overlap without extending onto the driving lane.
7. **Roll the Aggregate After Spreading.** As soon as practically possible, use

the rollers in a longitudinal direction. Ensure that each roller travels over the aggregate three times with the final pass in the direction of the chip spreader.

- 8. Sweeping After Placement.** Sweeping to remove loose stones after opening to traffic will be required as determined by the agency/owner representative. The contractor may use an arrow board, in bar mode, pulled behind a vehicle trailing the sweeping equipment. Conduct sweeping so loose aggregate does not migrate back onto the pavement. Use a pick-up sweeper to remove loose aggregate on curb and gutter sections.

Sweep when the surface is ready to be swept without causing excessive stone loss.

- 9. Cure Time and Opening to Traffic.**

Do not allow traffic until the chip seal has set enough to prevent loss or rolling of aggregate that exposes an uncured binder. For multiple layer chip seal an appropriate amount of wait time should occur between layer applications that achieve the best balance to the project scope and pricing, the project conditions, and the project performance objectives.

- 10. Application of Fog Seal.** The application of fog seal to the surface of a newly constructed chip seal is beneficial for three reasons. First, the light application of emulsified asphalt binder helps aggregate retention. Second, the emulsified asphalt fog seal changes the color of the surface creating a much sharper contrast between the pavement markings and the pavement surface, which improves visibility. Third, the pavement appearance is that of a new asphalt surface rather than a gravel or crushed stone surface which helps with public relations. The application of the fog seal should not be applied prior to 24 hours after placing the chip seal or before the surface has been swept.

F. Application Methods and Rates

- 1. Application Rate.** Ensure the application rate of binder is sufficient to result in at least 40 percent initial embedment of the aggregate and 70 percent after rolling.

2. Asphalt Binder

- a. Single Chip Seal.** Typical application rates for asphalt binder range from 0.35 gallons per square yard to 0.50 gallons per square yard. Apply the asphalt emulsion at a temperature of 160°F or above.

Typical application rate for hot applied binders ranges from 280 degrees to 310 degrees. The application rate ranges from .27 to .4 gallons per square yard.

- b. Double Chip Seal.** Typical application rates for asphalt emulsion range from 0.28 gallons per square yard to 0.32 gallons per square yard for the top course. Apply the first course as a single chip seal.

Typical application rate for hot applied binders ranges from .22 to .32 gallons per square yard.

3. Course Aggregate

- a. Single Chip Seal.** Apply coarse aggregate from 15 pounds per square yard to 25 pounds per square yard. The objective is to have a single layer of aggregate without unembedded stones.
- b. Double Chip Seal.** Apply coarse aggregate from 16 pounds per square yard to 20 pounds per square yard for the top course. Apply the first course as a single chip seal.

G. Notification and Traffic Control

- 1. Notification.** Homeowners and businesses affected by the construction must be notified at least one day in advance of the surfacing. Should work not occur on the specified day, a new notification will be distributed. The notification will take place in the form of a written posting, stating the time and date that the surfacing will take place. If necessary, signage alerting traffic to the intended project should be posted.

When parking restrictions are necessary, the agency/owner should prepare a plan for communication with residents and removing vehicles to allow the project to continue. Notices to homeowners and businesses should include plan details, including the schedule, agency/owner contact details and the towing company where a towed vehicle is located.

If an agency/owner is aware of abandoned vehicles, these vehicles should be removed in advance of the project allowing for cleanup of any materials or chemicals that could inhibit the bonding of the new surface.

- 2. Traffic Control.** An agency/owner approved traffic control plan is required before any work begins. The cost of signage, markers and traffic control necessary to complete the project will be included in the unit price of the chip seal. Traffic control devices must be in accordance with the agency/owner's requirements and conform to the requirements of the Michigan Manual for Uniform Traffic Control Devices.

5. Weather Limitations

Ambient temperatures should be at least 55° F.

Do not place chip if ambient temperatures are forecasted below 40° F within 24 hours of placement.

Do not apply chip seal in foggy or rainy weather.

Do not apply chip seal if the pavement temperature is equal to or greater than 130° F.

6. Quality Control and Acceptance

A. Quality Control Plan. Establish and maintain an effective QC plan and provide to the agency/owner as requested. Ensure that the QC plan details the procedures and organization to produce the required single, double, and shoulder chip seal operations. Provide the engineer with a copy of the QC plan for review and approval, prior to the pre-production meeting. Comply with the engineer-approved QC plan for the duration of the project and allow the engineer access to in-progress work for QA review and testing.

1. Daily Report. Submit a daily report to the agency/owner as requested with the following information.

- a. Project number or name
- b. Route or streets
- c. Date
- d. Weather information
- e. Asphalt emulsion application temperature
- f. Beginning and ending stations (placement and brooming)
- g. Material tickets for aggregate and binder; and
- h. Signature of the contractor's authorized representative

2. Acceptance

- a. **Field Inspection Acceptance.** Upon completion of work, schedule an inspection with the agency/owner. The agency/owner will note deficiencies, including areas exhibiting adhesion failure, cohesion failure, excessive stone, loss of stone, or other factors the agency/owner identifies as unacceptable. Correct work the agency/owner determines unacceptable.

7. Measurement and Payment

Pay Item	Pay Unit
Seal, Single Chip	Square Yard
Seal, Double Chip	Square Yard
Seal, Shoulder Chip	Square Yard

- 1. Seal, Single Chip.** The unit price for **Seal, Single Chip** includes the cost of placing a single application of asphalt binder and coarse aggregate to a pavement, material sampling and testing, surface preparation, brooming, traffic control and documentation.
- 2. Seal, Double Chip.** The unit price for **Seal, Double Chip** includes the cost of placing a double application of asphalt binder and coarse aggregate to a pavement, material sampling and testing, surface preparation, brooming, traffic control and documentation.
- 3. Seal, Shoulder Chip.** The unit price for **Seal, Shoulder Chip** includes the cost of placing a single application of asphalt binder and coarse aggregate to shoulders, material sampling and testing, surface preparation, brooming, traffic control and documentation.
- 4. Pavement Marking Removal.** The agency/owner may pay separately for removing pavement markings.

Commentary:

Shoulder Chip Seal: When using a standalone chip seal on the shoulder of asphalt roads, a smaller CST aggregate is recommended. See MDOT Special Provision for Chip Seal, Top Course 20RC505(A055), May 20, 2020.

Fog Seal Application: When applying a fog seal over chip seal, use the MRPA Guidelines for Fog Seal

For additional information review AASHTO Best Practice documents