10 Seal Coat Placement

Types of Seal Coats

Equipment

Distributor
Chip Spreader
Pneumatic-Tire Roller
Rotary Power Broom

Surface Preparation

Aggregate Surface
Prime Coats
HMA or Concrete Surfaces

Placement

Weather Limitations
Traffic Control
Application of Asphalt Material
Application of Cover Aggregate

Application Rate Computations

Asphalt Material
Cover Aggregate

CHAPTER TEN:
SEAL COAT PLACEMENT

Seal coating consists of the application of liquid asphalt material to the roadway followed immediately by the application of the aggregate. Seal coat applications may be for single or double coverage. Where double applications (which are sometimes called surface treatment) are used, the first application of asphalt material is covered with aggregate, rolled, and allowed to cure before the second coat is applied.

Seal Coats are covered in Section **404**. Seal coats may be applied to aggregate, concrete, or HMA surfaces; however, the most common use by INDOT is on HMA surfaces. When a seal coat is placed on an aggregate surface, a prime coat (Section **405**) is first applied and allowed to cure.

Seal coats are applied to HMA or concrete surfaces to:

1) Seal out moisture and air

2) Rejuvenate dry weathered surfaces

3) Improve skid resistance of the pavement

4) Improve visibility of delineation between the traveled way and the shoulders

Seal coats applied directly to roadways with aggregate surfaces provide a smooth, dust-free traveled way which eliminates the need for periodic re-grading of the surface. This method of construction is normally used only for low-volume roads.

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TYPES OF SEAL COATS

Seven types of seal coats are used as indicated in the table below. The types vary by the size of cover aggregate used and the number of applications. Types 1 through 4 use single applications and types 5 through 7 are double applications.

Type	Application	Cover Aggregate Size No.	Rates of Application per Square Yard	
			Aggregate (lb)	Asphalt Material (Gallons at 60°F)
1*	Single	23, 24	12-15	0.12-0.16
2	Single	12	14-17	0.29-0.33
3	Single	11	16-20	0.36-0.40
4	Single	9	28-32	0.63-0.68
5	Double	a. 11	16-20	0.36-0.40
		b. 12	16-19	0.33-0.37
6	Double	a. 9	28-32	0.63-0.68
		b. 11	18-22	0.41-0.46
7	Double	a. 8	28-32	0.63-0.68
		b. 11	18-22	0.41-0.46

* Only AE-90 or AE-150 is used for seal coat, type 1.

For double applications, the coarser aggregate is used for the first application. Section **904** includes the requirements for the aggregates, in the seal coat. The cover aggregates are required to be produced by a CAPP approved source.

The asphalt material is required to be RS-2, AE-90, AE-90S, or HFRS-2 as indicated in Section **902.01(b)**. Asphalt materials used for seal coats are accepted by a Type A certification supplied by the Contractor. The certification is required to have test results included that meet the requirements of the Specifications for the grade of asphalt supplied.

EQUIPMENT

Four major pieces of Contractor equipment are required for seal coating: a distributor, a chip spreader, a pneumatic-tired roller, and a rotary power broom.

DISTRIBUTOR

The asphalt distributor (Figure 10-1) is the most important piece of equipment on a seal coat operation. The uniform application of the asphalt material at the designated rate is essential to achieve a quality seal coat.

The distributor is required to be checked to ensure that the equipment is in good working condition and complies with the Specification requirements. The proper nozzles, nozzle angles, spray bar height, pump speed, and pump pressure are items that are required to be checked.

Figure 10-1. Asphalt Distributor

CHIP SPREADER

The chip spreader (Figure 10-2) receives the aggregate from the haul trucks and deposits the material uniformly over the full width of the asphalt material applied by the distributor. The spreader is required to spread the material uniformly without segregation so that the larger particles are applied to the surface ahead of the finer material.

Chip spreaders usually are self-propelled. Tailgate spreaders that hook onto dump trucks may be used for small quantities.

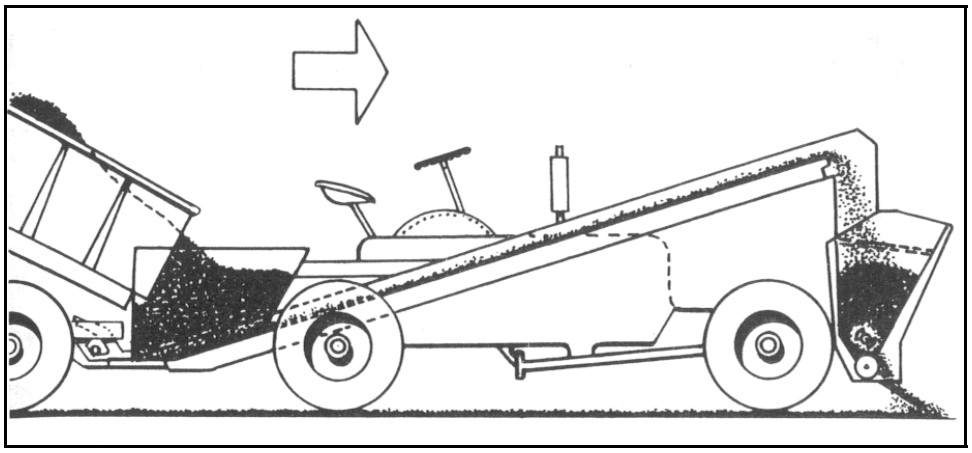

Figure 10-2. Chip Spreader

PNEUMATIC-TIRE ROLLER

The purpose of rolling with a pneumatic-tire roller (Figure 10-3) is to embed the aggregate into the asphalt material. Care is required to be taken in rolling to avoid moving the chips during the rolling process. A smooth, uniform operation of the roller is essential. Excessive breaking or sharp turns dislodge the cover aggregate from the asphalt material.

Figure 10-3. Pneumatic-Tire Roller

ROTARY POWER BROOM

A power rotary broom (Figure 10-4) is required for cleaning the surface prior to seal coating and may be needed to remove excess cover aggregate after the curing period. Typical power brooms are mounted on the front of tractors, although some manufacturers make special machines for this purpose.

Figure 10-4. Rotary Power Broom

SURFACE PREPARATION

Surface preparation is extremely important for successful seal coating. The surface is required to be clean, dust free, and dry to obtain proper adhesion of the seal coat. Preparation of the surface varies somewhat, depending on the type of surface.

AGGREGATE SURFACE

Aggregate surfaces are required to be brought to the proper crown and grade and thoroughly compacted. Aggregate surfaces that have been under traffic typically have potholes and chatter bumps (washboarding) which are required to be removed. Removal may be done by scarifying 3 in. deep, reshaping, and re-compacting. The surface is required to be free from all ruts, corrugations, segregated material, or other irregularities.

PRIME COATS

A prime coat is the application of asphalt material to an aggregate, stabilized base, or similar absorptive base that is to be given an asphalt surface. The purpose of the prime coat is to act as a bonding agent between the base and the seal coat. Prime coat materials penetrate into the base a slight amount to help hold down the dust which would prevent the seal coat from sticking.

Prime coats may be applied only when the temperature is 50º F or higher, unless written permission is given by the PE/PS. The existing surface is required to conform to the requirements for an aggregate surface before the prime coat is applied.

The asphalt material for a prime coat is required to be applied uniformly with a distributor at the specified temperature. The rate of application may vary from 0.25 to 0.80 gallons per square yard depending on the condition of the surface and the kind, gradation, and amount of loose aggregate. Skipped areas are required to be corrected and any excess material removed from the surface. Building paper is required to be placed over the ends of previous applications and the joining application started on the paper to prevent excess material build-up. The prime coat is cured when the material ceases to be tacky, usually within 24 hours. If the prime coat does not penetrate after a reasonable time and the primed area is required to be opened to traffic, cover aggregate is spread to absorb the excess material. When traffic is required to be maintained not more than one-half of the width of the roadway may be primed at one time.

HMA OR CONCRETE SURFACES

All defective areas and broken edges of existing HMA or concrete surfaces are required to be repaired prior to sealing. The old surface is brought to a reasonable degree of uniformity by correcting flushed or dry areas and patching potholes and dips.

Cleaning the existing surfaces may normally be done with a power rotary broom; however, mud or other foreign matter may require removal with shovels, hand brooms, or water.

PLACEMENT

WEATHER LIMITATIONS

The best weather for seal coating is hot and dry, during and after the application. Sealing is never started when the surface is wet or rain is threatening. The Specifications require that both the air and surface temperatures be at least 40º F. Seal coats may be placed when the air or base temperature is between 40º F. and 60º F only if the cover aggregate is

heated to between 120º F and 150º F. Emulsified asphalt is required to be used as the asphalt material.

If possible, seal coating is avoided when the temperature is below 60º F because the asphalt material cools very quickly at that temperature and the aggregate is less likely to be embedded properly. Seal coats are not applied to wet surfaces.

Special care is required to protect the traveling public from over-spray in windy weather. Sealing is not allowed in strong winds because crosswinds disturb the flow of asphalt materials from the nozzles which may cause spray interference and streaking.

TRAFFIC CONTROL

Because seal coats are often applied to road surfaces already open to traffic, special traffic control measures are needed. The seal coat is required to be protected from the traffic until the material has cured enough to prevent pick-up or displacement of the cover aggregate and until the chips are firmly embedded.

Traffic control is usually done during the initial curing period by the use of flagmen and pilot cars. Later, the traffic control may be handled with signing. Traffic is piloted through the work at speeds low enough to prevent damage to the newly placed seal coat. Normally, the speed should be less than 25 miles per hour. Care is required to be taken to prevent sudden starts or stops on the new seal. When stopping traffic on a new seal, additional cover aggregate may be necessary to cover the area where the vehicles park to prevent pick-up and tracking.

The length of time that traffic is controlled depends on the weather and the type of asphalt applied. During cool, damp, cloudy, or humid weather, longer control periods are necessary than when the weather is warm, dry, and sunny. Cool, damp weather delays the evaporation of the moisture in the cover aggregate and the setting rates of the asphalt material. During very hot weather, traffic is controlled longer if there is a possibility of chips rolling or picking up under traffic. Traffic is controlled during that portion of the day when damage may occur to vehicles due to flying rocks or to the seal coat. Traffic control may be necessary during the second day after seal coat placement.

Following an unexpected rainstorm, traffic is kept off of the new seal coat until the cover aggregate has dried. If this is not possible, controlling traffic at an extremely slow rate is necessary and rolling is not continued until the danger of dislodging the aggregate has passed.

Traffic control is provided and the work scheduled to handle the traffic with a minimum delay. Most extended delays, exposure of the traffic to unnecessary hazards or inconveniences, or damage to the seal coat are the result of poor planning for traffic control. Traffic is never allowed to pass a distributor which is applying asphalt material if there is any possibility of asphalt being sprayed on the vehicles.

APPLICATION OF ASPHALT MATERIAL

Asphalt material is applied to the roadway with a pressure distributor to obtain a uniform application. The distributor is required to heat the material to the designated temperature range. A continuous, uniform application of the asphalt material over the width to be sealed is required for a good seal coat. The distributor is tested for uniform application prior to beginning the sealing operation. The distributor is never more than 500 ft ahead of the chip spreader.

The biggest problem in applying asphalt materials is the prevention of streaking. Streaking results in narrow longitudinal ridges with either an excessive amount of asphalt or insufficient asphalt, and is usually caused by one of these conditions:

1) Asphalt at the improper temperature

2) Interference of the sprayed material from one nozzle with that of adjacent nozzles

3) Improper pump speed

4) Improper spray bar height

5) Clogged nozzles

Malfunctions that cause streaking may be corrected by the following procedures:

1) The temperature of the material is required to be checked and maintained toward the top of the range.

2) The long axis of the nozzle opening is required to be set to conform to the manufacturer's recommendations. All nozzles are set at the same angle to prevent interference. The use of a special wrench or other methods of checking that are not visual are recommended. Generally, the smaller the nozzle opening, the more uniform the application of asphalt material. The spray fan appears

3) distorted if the slot in the nozzle is worn or damaged. Worn or damaged nozzles are required to be replaced.

4) The highest possible pump speed that does not cause distortion and/or atomizing in the spray fan is the correct speed to use. Low speed applications result in streaking and non-uniform discharge. Manufacturers provide charts and data for proper pump speed or pressure and for determining the discharge in gallons per minute for each nozzle size.

5) Most clogged nozzles are the result of allowing the spray bar to cool between applications, causing the material to harden. Circulating the hot material through the spray bar until the bar reaches the temperature of the material generally melts the obstruction. A quick test shot before starting is recommended.

6) Improper spray bar height is the principal cause of streaking. Visual observation while the distributor is moving does not reveal whether an exact double or triple lap is being applied. Without prior checking, only time reveals the lack of uniformity of the seal coat application.

A method for determining the correct spray bar height is described as follows. With alternate nozzles plugged and the pump speed determined in (3) above, the spray bar height is varied in increments not greater than 1/2 in. until an exact single lap is applied to the surface for the width of the spray bar being used. The spray bar height that gives an exact single lap with alternate nozzles plugged yields an exact double lap coverage with all nozzles operating. When the correct spray bar height has been determined, the height is required to be kept constant throughout the application. For good results, the variation in spray bar height between the loaded and unloaded distributor should not exceed 1/2 in.

The best results with 4-in. nozzle spacing may be obtained with an exact triple lap of the spray fans. With 6-in. nozzle spacing, the height of the bar is too high and subject to wind distortion for a triple lap; therefore, a double lap is used.

Transverse Joints

Rough or unsightly transverse joints may be avoided by starting and stopping the asphalt and aggregate spread on building paper. The paper is placed across the lane to be treated so the forward edge is at the desired location. The distributor, traveling at the correct speed for the desired application rate, starts spraying on the paper so there is a full uniform application when the exposed surface is reached. A second length of

building paper is placed across the lane at the predetermined cutoff point for the distributor. This procedure gives a straight, sharp transverse joint. After the aggregate spreader has passed over the building paper, the paper is removed and discarded.

For the next application, the leading edge of the paper is placed within 1/2 in. of the cutoff line of the previously laid treatment. This procedure prevents a gap between the two spreads.

Longitudinal Joints

Full-width applications of asphalt and aggregates eliminate longitudinal joints. In most seal coat work, the joint is unavoidable because the roadway is too wide for one pass or traffic lanes are required to be maintained.

To prevent aggregate from building up on the longitudinal joints, the edge of the aggregate spread is required to coincide with the edge of the full thickness of applied asphalt. This procedure allows a width where asphalt is present in partial thickness to be overlapped when asphalt is applied to the adjacent lane. The partial thickness is the result of the outside nozzle spray being only partially overlapped. In this way there is no build up at the joint when the aggregate is spread for the full width in the next lane. The width of the asphalt strip left exposed varies depending on the nozzle spacing and whether the asphalt is a double or triple lap spray pattern.

If possible, the longitudinal joint is required to be along the centerline of the pavement being treated. An established line ensures a straight longitudinal joint.

The distributor is parked off the roadway when not in use so the spray bar or mechanism does not drip asphalt materials onto the traveled way, either before or after seal coating.

APPLICATION OF COVER AGGREGATE

Cover aggregate is required to be clean and sufficiently dry so that a satisfactory bond is obtained. If the aggregate is dusty, the material is moistened with water to eliminate or reduce the dust coating on the aggregate at least 24 hours prior to use. The moisture content should not exceed 3 %.

When the distributor moves forward, the aggregate spreader follows immediately behind. Enough trucks are required to be available to cover the asphalt before allowing the distributor to begin. When asphalt emulsions are used, the cover aggregate is required to be applied before the emulsion starts to break. The aggregate is required to be spread uniformly and at the proper rate. In a single application, aggregate

normally does not stick to the asphalt more than one particle thick; therefore, applying the asphalt at a rate greater than a single layer is wasteful.

Rolling seats the aggregate in the asphalt and promotes the bond necessary to resist traffic stresses. Pneumatic-tired rollers are required for seal coating. Steel-wheel rollers generally only compact the high spots. Pneumatic-tired rollers apply uniform pressure over the entire area.

Immediately after the cover aggregate is spread but before rolling, any area with a deficiency or surplus of aggregate is required to be corrected. Rolling begins immediately behind the aggregate spreader and continues until at least three complete roller coverages have been made. Rolling is required to be completed within 30 minutes after the cover aggregate is applied and before the asphalt cools or sets.

The finished seal coat is required to exhibit a tightly knit surface one particle thick (single seal), with enough asphalt binder to embed the aggregate 50 to 70 percent of the aggregate particle. A common tendency is to apply both the aggregate and the asphalt at an excessive rate.

Fuel or hydraulic fluid leaks from the equipment ruin the appearance of the seal coat, cause permanent damage, and are avoided.

Despite precautions, there is usually loose aggregate on the road surface after rolling is completed. Before the adjacent lane is covered with asphalt, loose aggregate is required to be swept from along the longitudinal joint and, if necessary, from the remainder of the uncovered lane. Excess aggregate from each course is removed with a light brooming on the day following placement. The brooming is required to not displace the embedded aggregate.

APPLICATION RATE COMPUTATIONS

ASPHALT MATERIAL

The Specification application rates for asphalt materials are based on material at 60º F. Since the material is applied at a higher temperature and expands in volume when heated, an allowance is required to be made for the increase in volume.

The formula for calculation of the volume at 60º F from a volume at an observed temperature is:

$$V = \frac{V_1}{K\,(T - 60) + 1}$$

where: V = volume at 60º F.
V_1 = volume at the observed temperature
T = observed temperature in degrees F
K = coefficient of expansion of asphalt material

The coefficient of expansion to be used in making the volume corrections for asphalt emulsion is 0.00025/° F.

Distributors are required to have a gauge for determining the gallons of material in the tank before and after each application. The difference is the amount applied; however, weighing the distributor before and after is another acceptable method. The weight of asphalt material in the tank may be converted to a volume in gallons with the following formula:

$$G = \frac{W}{S.G \times 8.328}$$

where:
G = volume in gallons at 60º F
W = weight of asphalt material in pounds
S.G. = specific gravity of asphalt material at 60º F
8.328 = the weight of one gallon of water at 60º F

The laboratory report with the certification indicates the specific gravity and the weight per gallon at 60º F for all asphalt materials.

Example #1 – Determine application rate

Plan rate of application of AE - 90 is 0.32 gal/yd^2 at 60º F

Temperature of the asphalt in the distributor is 270º F

K = 0.00025

$V_1 = V\,(K\,(T\text{-}60) + 1)$

$V_1 = 0.32\,(0.00025\,(270\text{-}60) + 1)$

V_1 = 0.34 gal/yd^2 at 270º F

Example #2 – Determine distributor speed

The speed of the distributor and length of spread are determined before spraying starts. The distributor speed may be determined by the following formula.

$$V = \frac{9\,Q}{WA}$$

where: V = road speed in feet per minute
Q = spray bar output in gallons per minute
W = spray bar width in feet
A = application rate in gallons per square yard at the application temperature (as computed in Example #1)

Asphalt material as in Example #1
Spray bar width = 12 feet
Pump capacity = 325 gallons per minute

$$V = \frac{9 \text{ x } 325}{12 \text{ x } 0.34} = 713 \text{ feet per minute}$$

Example #3 – Determine actual application rate

Width of application = 12 feet
Beginning station = 10+00
Ending station = 15+75
Gallons in tank at start = 1230
Gallons in tank at end = 960
Temperature in the distributor = 270º F
Type of material = AE - 90

$$\text{Area covered} = \frac{12\,(1575 - 1000)}{9\ \text{ft}^2/\text{yd}^2} = 767\ \text{yd}^2$$

$$\text{Application rate} = \frac{1230 - 960}{767} = 0.35\ \text{gal/yd}^2 \text{ at } 60^\circ \text{ F}$$

$$V = \frac{V_1}{K\,(T - 60) + 1} = \frac{0.35}{0.00025\,(270 - 60) + 1} = 0.33\ \text{gal/yd}^2 \text{ at } 60^\circ \text{ F}$$

The actual rate of application of 0.33 gal/yd^2 is slightly higher than the planned rate of 0.32 gal/yd^2 but within reasonable tolerances.

Example #4 – Convert weight to gallons

Weight of asphalt material = 14,000 lb
Specific gravity at 60º F = 0.980

$$V = \frac{14{,}000}{0.980 \text{ x } 8.328} = 1715 \text{ gallons at } 60^\circ \text{ F}$$

COVER AGGREGATE

Application rates for cover aggregate are determined in a similar manner as the application rates of asphalt material.

Example #5 – Determine the cover aggregate application rate

Weight of cover aggregate applied = 15,200 lb. (from weigh tickets)
Use the area covered from Example #3

$$\text{Application rate} = \frac{\text{quantity used}}{\text{area covered}} = \frac{15{,}200}{767} = 20 \text{ lb/yd}^2$$

The actual rate is compared with the planned rate. Adjustments in the gate opening are required to reduce or increase the actual rate to conform with the planned rate.

Test runs are required to be made to check the application rates of both the asphalt and cover aggregate prior to commencing sealing operations.