Asphalt Seal Coats

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16. ABSTRACT

This is a manual written for those who direct or physically construct asphalt seal coats. The text is based on field experiences.

The manual contains:

- The reasons for seal coating.
- Each type of seal coat is discussed as to the purposes of the seal and how it is constructed.
- Particular emphasis is on chip seals and the factors which can affect obtaining consistently good seal coats. Some of these factors are the weather, the road surface on which the seal is laid, the type of asphalt used, the handling and storage of the asphalt, the choice of cover rock, how to control the uniform distribution and application of the asphalt and rock, the coordination of the seal coat operation, and the post-seal inspection and possible immediate correction.

This manual is concise but detailed in the appropriate areas with liberal use of graphics.

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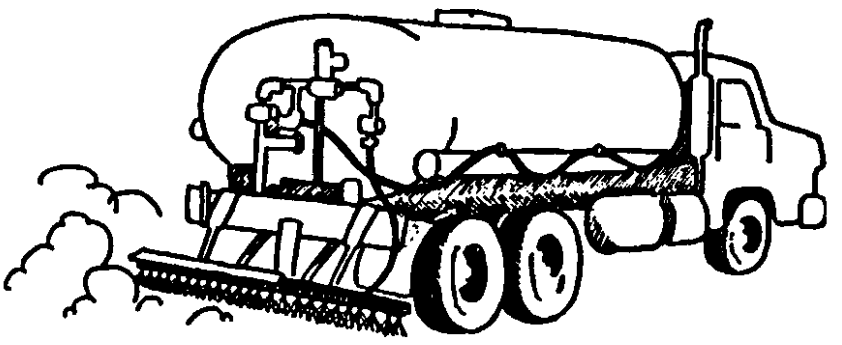
ASPHALT SEAL COATS

Factors Affecting
and
Techniques for Obtaining
Consistently Good
Seal Coats



by Coleman P. Wyckoff

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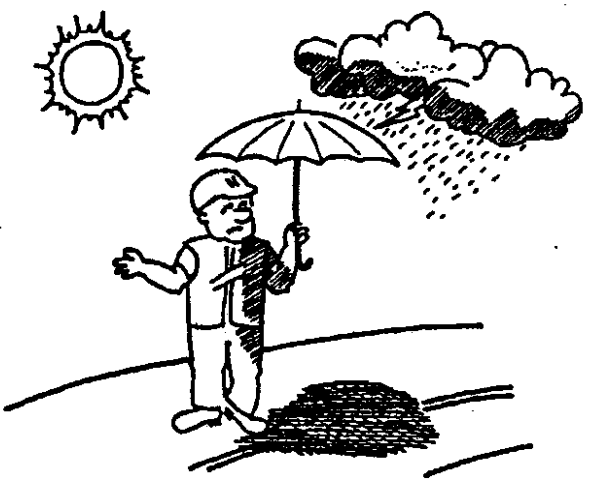
WHY SEAL COAT?



Seal to establish all weather surfaces that are

- maintenance free,
- dust free.

Seal to maintain the existing pavement in its present condition by

- delaying or eliminating further aging due to water and sun.

Seal to change the texture of the road to be

- non-skid,
- smoother,
- uniform in appearance.

Seal to change the color

- by sealing the shoulder for demarcation from the main pavement,
- of the entire pavement surface and to improve light reflection.

Seal to supply minimal additional strength to the pavement.

Seal to provide a moisture barrier.

Seal to give better resistance to studded tires.

Seal to correct existing pavement problems by

- waterproofing openness,
- enriching under-asphalted pavement either asphalt concrete or seal coats,
- performing minor leveling,
- sealing cracks either temporarily or permanently, depending on the cause.

Seal for economic reasons:

- a seal can be less expensive than continual maintenance of a gravel road;
- a seal can be an interim step to an asphalt mixed pavement;
- a seal can economically prolong the life of an existing pavement.

TYPES OF SEALS

FOG SEAL

What is it?

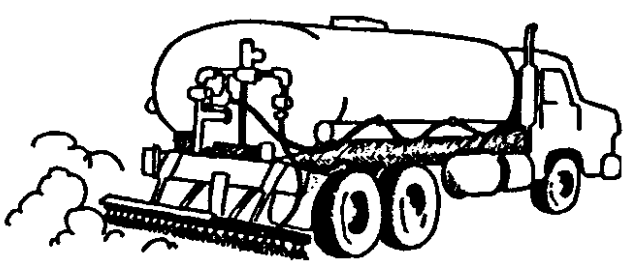
It is an application of a dilute emulsion without an aggregate cover.

Purpose

Its purpose is to seal and enrich an under-asphalted surface or to tighten and waterproof an open texture pavement. Fog seals can also be used as pre-seals.

How is it done?

Generally, a Cationic Slow Seal (CSS-1) or CSS-1h emulsion is diluted up to 50/50 with water. The CSS-1 can be diluted by either adding the water to the emulsion or the emulsion into the water. The former method usually generates more foam, depending on the drop from the fell stem and the water pressure. It is applied at .1 to .15 gallons of the dilution per square yard. (Application can vary depending on pavement texture, local conditions, and traffic.) It is desirable to keep traffic off the fog seal until the emulsion cures (turns black). However, traffic can use it immediately but at a reduced speed to prevent skidding and/or splashing on the cars. The skid resistance of the pavement may be reduced until traffic wears some of the asphalt from the surface.



CONSTRUCTION SEAL (FOG SEAL)

What is it?

It is an application of a dilute emulsion, usually the same material used for the tack coat.

Purpose

It is to enrich or tighten a new asphalt concrete surface to provide resistance to the entrance of moisture and/or to prevent ravelling under traffic. This treatment is particularly helpful with late season paving.

How is it done?

The most satisfactory method is to apply the same product used for the tack coat to the new asphalt concrete immediately following the final rolling while the pavement is still warm. The emulsion (a 50/50 dilution of CSS-1) should be applied at the rate of .05 to .12 gallons of the dilution per square yard. (Application can vary depending on pavement texture, local conditions, and traffic.)

SAND SEAL

What is it?

It is an application of an asphalt followed by a sand cover aggregate.

Purpose

This sand seal is intended to be used on pavements that have lost some of their matrix, and it is desirable for tightening the pavement texture and reducing ravelling.

How is it done?

Either a Cationic Rapid Set (CRS-1) or CSS-1 can be used. The CSS-1 generally is used in a dilute form (up to 50/50 dilution with water). The rate of application varies with the pavement texture from .1 to .2 gallons per square yard. (Application can vary depending on local conditions and traffic.) A variety of sands can be used. Preferrably the sand should be 3/8" or smaller, clean, and easy to handle. The sand can be applied immediately for maximum stick. However, if the emulsion is allowed to break (turn black) on the top of the rock in the pavement, and then the sand is applied, the sand is held only in the pores of the pavement. With this method, the resulting surface is similar to the original texture of asphalt concrete. Pneumatic tire rolling is desirable but not entirely necessary.

SLURRY SEAL

What is it?

It is a mixture of a specially graded aggregate and an asphalt emulsion. It is applied with a squeegee device.

Purpose

A slurry will seal an existing pavement and produce some minor leveling without the inconvenience of loose cover stone. It can also be used for mass crack filling, to improve skid resistance, to enhance appearance, and to reduce studded tire wear. A slurry made with a coal tar emulsion can protect the pavement in parking areas from damages by petroleum spills and drips.

How is it done?

Aggregates are generally selected using the International Slurry Seal Association (ISSA) grading specification (below). The largest aggregate varies from 1/4" to 3/8", depending on the application.

Sieve Size	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing
3/8	100	100	100
No. 4	100	90-100	70-90
No. 8	90-100	65-90	45-70
No. 16	65-90	45-70	28-50
No. 30	40-60	30-50	19-34
No. 50	25-42	18-30	12-25
No. 100	15-30	10-21	7-18
No. 200	10-20	5-15	5-15
Theoretical Asphalt Content % Dry Aggregate	10-16	7.5-13.5	6.5-12

Aggregates, which are entirely manufactured, seem to give a better end product and a more durable slurry seal. This aggregate is mixed with a CSS-1, CSS-1h or Cationic Quick Set (CQS-1h) asphalt emulsion. The percent of emulsion is determined by specifications and tests set forth by the ISSA. Slurries are produced in transit mix trucks or specially designed slurry seal equipment and are laid through a drag box with a rubber squeegee strike off. Traffic must be kept off the slurry until it is cured.

CAPE SEAL

What is it?

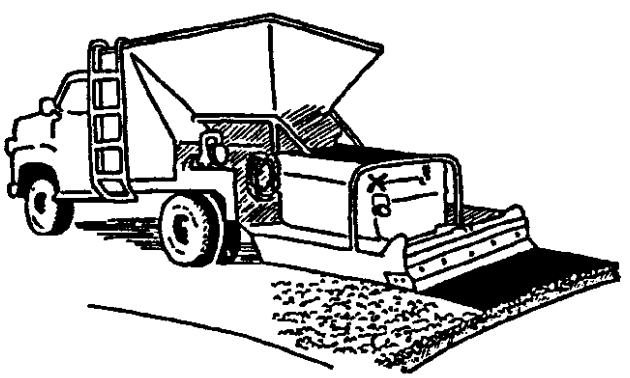
A cape seal is a chip seal topped with a slurry seal.

Purpose

A cape seal produces a seal with no loose cover stone. The maximum size of chip used for the seal coat will establish the depth of the mat. This seal may be the best suited for roads with high traffic volumes.

How is it done?

A chip seal is laid in the conventional manner. After the chip seal has cured, the loose cover stone is removed. Then the slurry is applied over the seal to fill the voids between the cover stones.



CHIP SEAL

What is it?

A chip seal is an application of asphalt followed with an aggregate cover.

Purpose

A chip seal is constructed to produce an initial pavement or maintain an existing asphalt pavement.

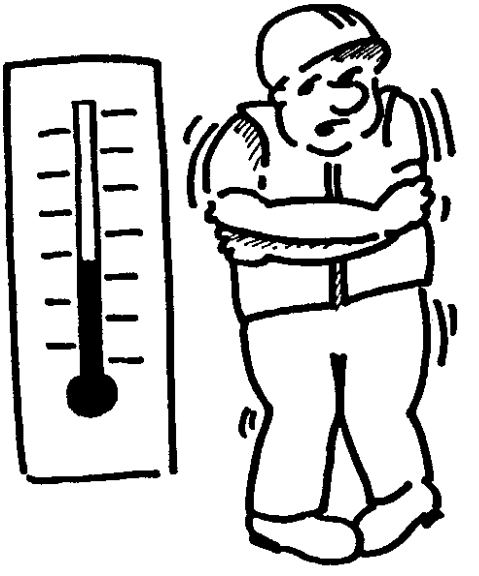
How is it done?

The technique of constructing a chip seal and its success are influenced by a number of factors. They include

- the weather,
- the surface on which a chip seal is laid,
- the grade of asphalt used,
- the method of storing and handling the asphalt,
- the type and size of rock used as cover aggregate and the dust and moisture on the stone,
- the application rate of the asphalt and the rock,
- the adjustment and operation of the equipment for applying the asphalt and rock,
- the coordination of the operation,
- the rolling,
- the traffic control during and after the seal coat is laid,
- the brooming, and
- the post-seal inspection and the application of a fog seal, if necessary.

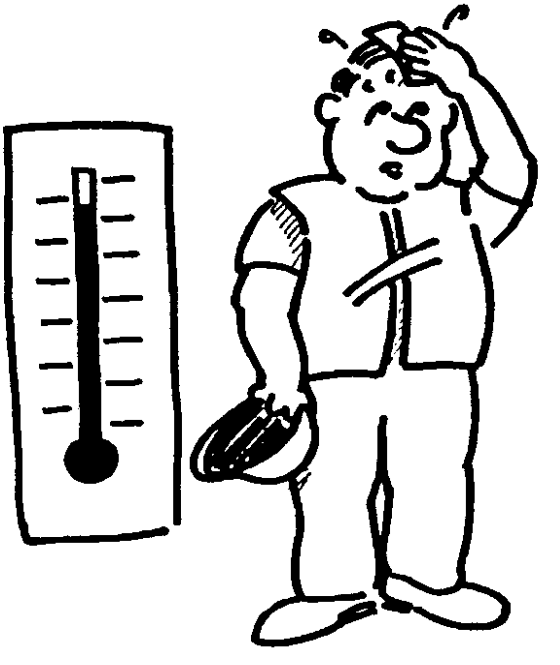
EFFECTS OF WEATHER

Weather can have a marked effect on the quality of a seal coat. These variations can be cool temperatures, hot temperatures, rain, and wind.



COOL TEMPERATURES

Cool air or pavement temperatures (under 55°-60° F) can affect the binding characteristics of the asphalt by making it less tacky (sticky) and/or increasing its viscosity. This can result in a poorer bond between the existing paving, the asphalt, and the rock. Further, it can reduce the embedment of the rock into the asphalt. In either case, it can result in extensive rock loss. A moderate increase of the asphalt application rate in cooler conditions seems to improve the rock retention. An asphalt with some cutter remains tackier in these cooler conditions. However, with the higher shot rate and the cutter, there is the possibility of flushing or bleeding when the weather warms.

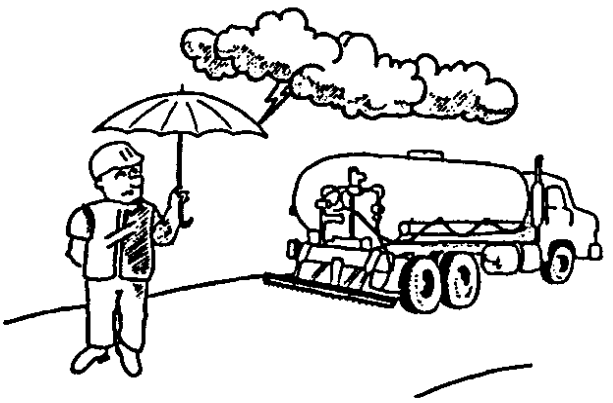


HOT TEMPERATURES

Sealing in hot weather (air temperatures of 90° F and higher) can also create some construction problems with a seal coat. Pavement temperature can be 150° F or higher. At these elevated temperatures, the asphalt is less viscous (more fluid) and does not have its full strength (adhesiveness). This is particularly true with the cutbacks. The cutbacks contain a petroleum solvent (cutter). While the cutter remains, the cutback is more fluid and has less strength at these elevated temperatures. A better choice may be a paving grade asphalt or an emulsion. The asphalt in these forms can be less susceptible to hot weather. Traffic control and a dry choke also help protect the new seal in hot weather.

RAIN

Seal coating must be postponed, if there is rain or the threat of rain. The cutbacks can float up through the cover aggregate in a rain and be picked up on the tires of the vehicles. The paving grades and the emulsions require less curing time to be resistant to rain.



If a seal is caught with an early rain, several steps may help save the seal:

- close the road to traffic (which is usually impractical);
- reduce the speed of the traffic; and
- apply additional cover stone.

WIND

Sealing during high winds should be discouraged. High winds can distort the spray pattern from the distributor and prevent a uniform asphalt application. Further, high winds can blow dust onto the road surface to be sealed or onto the freshly laid asphalt before the cover rock can be applied.

SEASONAL RESTRICTIONS

Late spring to early fall is the season most likely to have the weather that is most favorable for seal coat construction. Generally, there are more daylight hours during this time of the year.

SURFACE FOR A CHIP SEAL

Seals can be successfully constructed on a variety of surfaces:

UNTREATED BASE

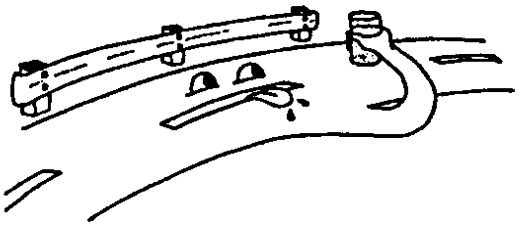
An untreated base should be adequately strong to carry the anticipated traffic and should be constructed with proper drainage. It should be prepared with a uniform texture and grade on which to apply the seal.

The asphalt can be applied to either a dampened thin layer of loosened top course (float) or a moist, tightly bound surface. Each has its advantages.

- Shooting into float can result in better penetration of the asphalt into the base rock and possibly a thicker mat.
- A tightly bound base gives uniform surfaces on which to shoot. This tight surface contributes to uniform rock retention. Mat thickness is obtained by inverted penetration into the cover rock.
- Either method results in approximately the same mat thickness using the same asphalt application rates.
- If the untreated base has been carrying traffic, all rutting and corrugations must be removed before the surface is shot.

DRY OR OPEN PAVEMENT

Dry or open pavement will absorb some of the asphalt intended for the new seal coat. Thus, a higher application rate or a pre-seal must be considered.

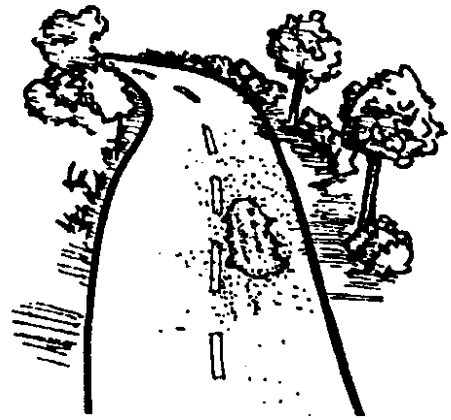


FAT (FLUSHING) PAVEMENTS

It is difficult to determine the proper asphalt application rate on a fat (flushing) pavement. The surplus asphalt in the underlying pavement may come up through and embed the new chips. The cutter remaining in the original fat pavement may penetrate and soften the asphalt in the new seal. It may be necessary to remove these fat areas prior to placing the chip seal.

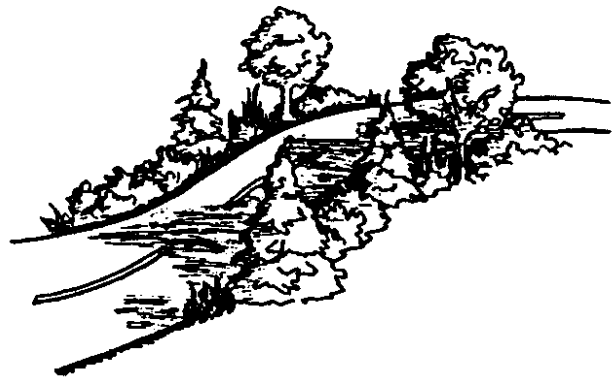
PATCHED PAVEMENT

Frequently, the patches are more open (absorbent) than the surrounding pavement. Either the patch must be pre-sealed or the asphalt application rate increased to avoid rock loss in the patched areas.



HEAVILY SHADED AREAS

Seal coating pavements in heavily shaded areas can result in rock loss when ordinary asphalt application rates are used. A heavier application frequently helps. Asphalt containing a cutter is more tacky, which seems to give better adhesion under these conditions. The use of a cutback or a Cationic Medium Set (CMS-2) emulsion in heavily shaded areas can minimize rock loss.



GRADES OF ASPHALT FOR SEALS

There are three basic types of asphalt used for seals.

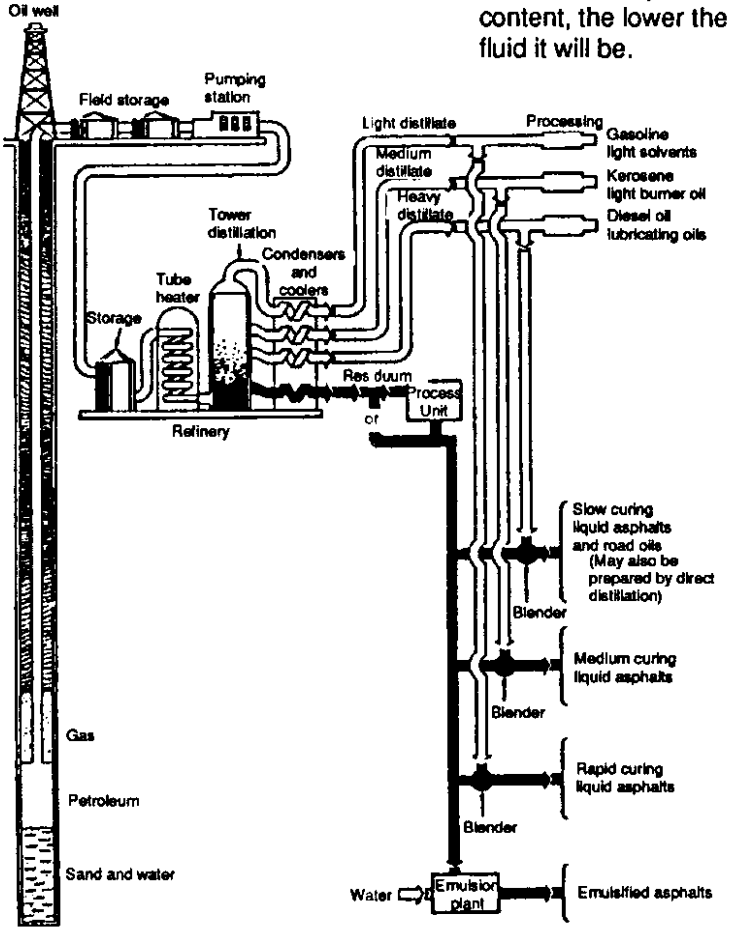
PAVING GRADE ASPHALTS

The paving grade asphalts (asphalt cements) are straight refined asphalts. They are refined to a specific hardness or viscosity.

CUTBACK ASPHALTS

The cutback asphalts (liquid asphalts) are asphalts that are dissolved in a petroleum solvent (cutter).

- The hardness of the asphalt selected is based on the temperatures the asphalt will be subjected to on the roadway.
- The type of solvent controls the curing time of the cutback and thus when the cutback will obtain its ultimate strength. The Rapid Curing (RC) cutbacks with naphtha (gasoline) cutter cure more rapidly than the Medium Curing (MC) cutbacks with the kerosene cutter.
- The amount of cutter affects the viscosity of the cutback asphalt. The higher the cutter content, the lower the viscosity and the more fluid it will be.



Courtesy of the Asphalt Institute

ASPHALT EMULSIONS

The asphalt emulsions are a suspension of asphalt in water.

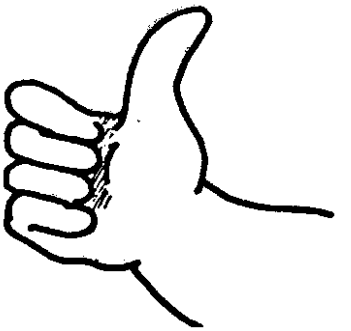
- Emulsions are made with different grades (hardnesses) of asphalts for varying climatic conditions.
- The emulsions are manufactured with several different formulae for use in the construction of seals or mixes.
- The anionic and cationic emulsions have different electrical charges. The choice of which type of emulsion to use depends on the electro-chemical characteristics of the rock available.
- Varying amounts of cutter are used to alter the emulsion for specific applications.
- The grades of emulsions are manufactured to have different viscosities and curing times to meet specific construction needs.

ADVANTAGES AND DISADVANTAGES

Paving Grades

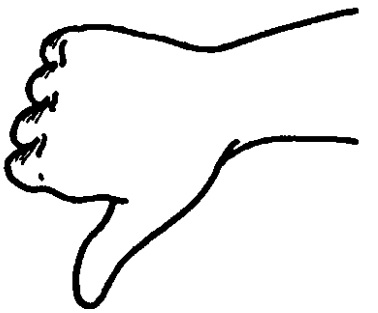
The paving grades have the advantages of

- being made of pure asphalt,
- requiring little or no curing period. As soon as they have cooled, they obtain their full strength (holding power).



The paving grades have several disadvantages:

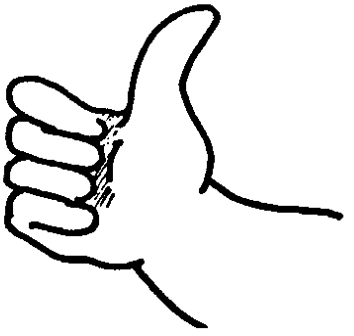
- They require high application temperatures (250° to 450° F) to make them fluid enough to handle well.
- The cover stone must be applied rapidly into the asphalt cement before it becomes less fluid (too stiff). If there is a delay, it is difficult to completrely embed the rock into the asphalt. Heating the cover stone is a means of improving the embedment. However, the disadvantages of this are heating costs and the generation of fines.
- Working at these high application temperatures, handling the asphalt cement becomes hazardous.
- It may be difficult to maintain the application temperature without reheating.



Cutbacks

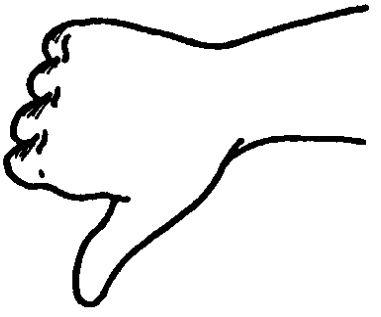
Cutbacks have several adavantages.

- They are fluid at lower application temperatures (50° to 250° F).
- They remain fluid for a longer period after they have been applied to the road, which permits some latitude between their distribution and the application of rock.
- Some of the cutter remains in the cutback for an extended period. This allows a cutback seal to remain flexible to conform to some movement in the underlying pavement and base. A cutback can have self-healing characteristics with minimal cracking.
- The cutback can tolerate some fines in the cover aggregate. The kerosene cutter is more tolerant than the naphtha to these fines.
- Mixes can be made with unheated aggregates and some cutbacks.



The disadvantages of cutbacks are as follows.

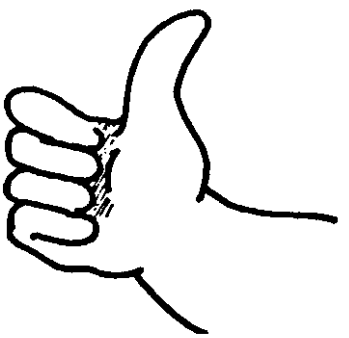
- The cutbacks do not obtain their ultimate strength until a good part of the solvent has escaped (evaporated). During the "curing period," the rock can be displaced under heavier traffic, particularly in warm weather. During this same period, early rain can float the cutback to the top of the rock and can be tracked away under traffic. The type of cutter solvent affects the "curing period."
- There is a potential fire hazard using cutbacks that contain petroleum solvents.
- In certain areas, air pollution is a concern as the solvent evaporates into the atmosphere.
- Excessive moisture on either the pavement to be sealed or the cover rock can hinder good adhesion with a cutback.



Asphalt Emulsions

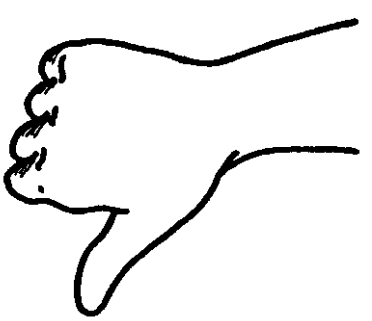
Asphalt emulsions have the following advantages.

- They are handled at cooler temperatures (50° to 150° F).
- Mixes can be made with damp and cool aggregates.
- Most emulsions contain an anti-strip additive.
- The seal coating grades of CRS-2 and CMS-2 cure more rapidly than the cutbacks under most conditions.
- The emulsions can be made with a high viscosity to resist runoff on supers, crowns, and grades.
- They are made with selected grades of asphalt cement for use under different temperature conditions.
- The water phases make them less of a fire hazard to use.
- Lower handling temperature results in less burn hazard.
- The emulsions can be manufactured with varied percentages of solvent. The selection of the appropriate solvent and content can:
  - affect the curing characteristics of the emulsion,
  - affect the flexibility and self-healing characteristics of the seal coat, and
  - permit the use of cover aggregates containing fines.
- The grades of CSS-1, CMS-2, and some high float (HF) emulsions can be diluted with most waters to change their viscosity and asphalt content.

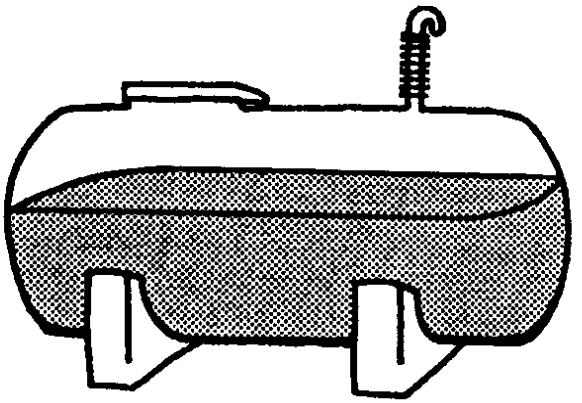


The asphalt emulsions have several disadvantages.

- If they are overheated (boiled) or frozen, they can break and become unusable.
- Emulsions are not compatible with cutbacks or asphalt cements.
- Anionic and cationic emulsions are not compatible.

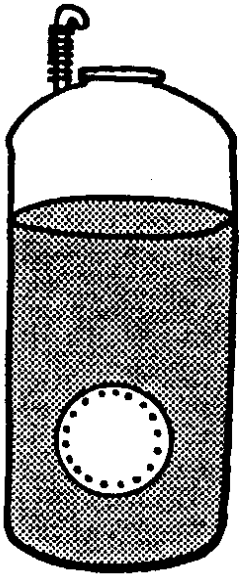


STORAGE AND HANDLING OF ASPHALTS



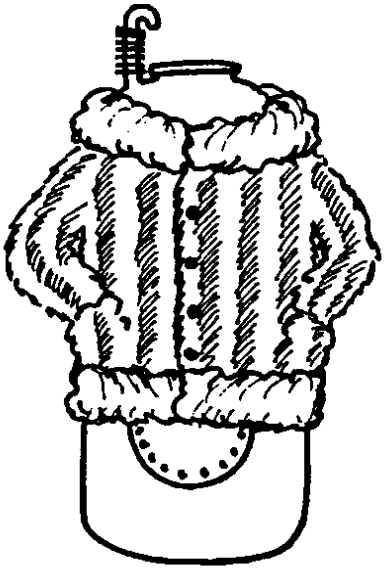
TYPES OF ASPHALT STORAGE

Most asphalt storage tanks are horizontal. This can make them portable and easy to move.



However, vertical tanks

- conserve space,
- are more economical to construct,
- are more efficient for maintaining heat on the asphalt, and
- may expose less asphalt to the air, depending on the configuration of the tank.



INSULATION OF ASPHALT TANKS

Insulation helps maintain a more uniform temperature throughout the tank, saves heating costs, and reduces and delays coke (carbon) buildup on heating tubes.

HEATING OF ASPHALT STORAGE TANKS

Electric Heat

Electric heating units are a popular method for maintaining the temperature in an asphalt tank, particularly in areas of inexpensive electric power.

Low density heating (3 watts per square inch of heating surface) reduces the tendency of hot spots around the heating tube and reduces the coke buildup.

Flue Type Heaters or Coils

These are acceptable methods for heating asphalts.

If the asphalt can be circulated during heating, more efficiency can be accomplished and spot overheating can be reduced or eliminated. This is particularly true with the flue heaters and coils.

The asphalt level in the tank should be maintained above the coils or tubes during the heating process.

There is a close relationship between storage and application temperatures. Asphalt held in storage at spray temperatures maintains a uniform viscosity, handles well, and gives a good spray pattern through the distributor. Temperature viscosity curves can establish the optimum temperature that will give a consistent viscosity. There are variances within the specification limits from different suppliers. The Washington State DOT 1987 Standard Specifications can be used as a guide. At right are its recommendations for application temperatures.

It may be desirable to maintain the temperature somewhat below the maximum recommendation to reduce fire hazards with the cutbacks and the danger of breaking the emulsions by overheating.

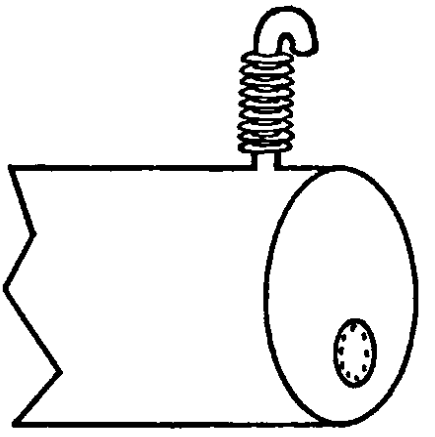
Overheating is undesirable because

- additional heating costs;
- the paving grades will become harder with extended heating;
- higher heating temperatures can drive off (evaporate) solvents from the cutbacks, make them more viscous, and change their handling and performance characteristics; and
- moderate overheating of an emulsion will drive off some of the water, make the emulsion more viscous, and change its performance. More severe overheating can break the emulsion.

Type and Grade of Asphalt	Distributor Spraying Temperature Min. Degrees F	Max. Degrees F
LIQUID ASPHALTS		
MC, RC70, Viscosity	120	180
MC, RC250 Viscosity	165	220
MC, RC800 Viscosity	200	225
MC, RC3000 Viscosity	250	300
ASPHALT EMULSIONS		
CSS-1, CSS-1h, STE-1	70	140
CRS-1, CRS-2, CMS-2,	140	185
CMS-2s, CMS-2h	140	185

EXTENDED STORAGE AND HEATING OF ASPHALTS

If the asphalt must be stored for extended periods, follow these precautions.

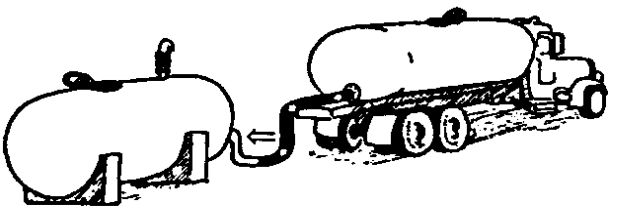


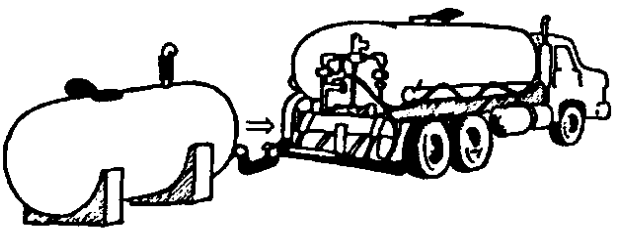
With Paving Grades or Cutbacks

- It is desirable to lower the storage temperature to prevent the loss of light ends or solvents.
- The storage tank should be equipped with a fin vent, which will condense the light ends or solvents back into the tank, rather than losing them into the atmosphere.

With Emulsions

- A lower storage temperature is desirable.
- With extended storage, a skin will form on top of the emulsion where it is in contact with the air. Floating a layer of solvent such as a naphtha or kerosene on the surface of the stored emulsion will prevent or reduce this formation of skin.
- Occasional circulation is helpful.
- It is desirable to fill and load out of the storage tank from the bottom.
- If the storage tank is filled through the top, any skin that may have formed can break up into small chunks of asphalt that can plug pumps and snivies.

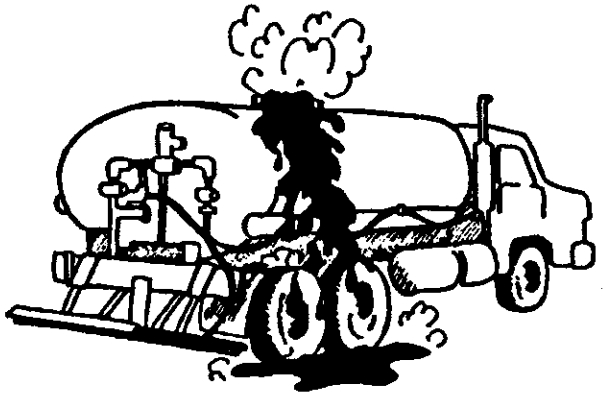


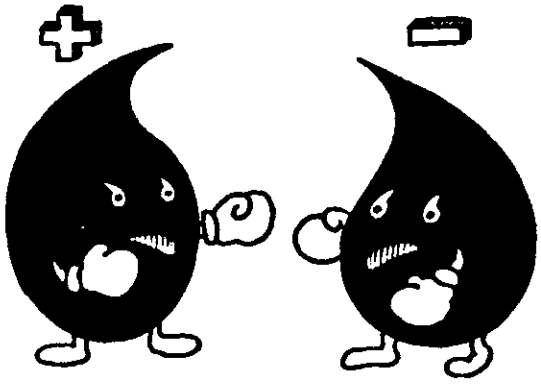


CO-MINGLING OF ASPHALTS

Co-mingling of grades of asphalt is a practical necessity; however, there are certain limitations.

- Small amounts of different cutbacks or cutbacks and paving grades can be co-mingled. However, the resulting product will assume some of the characteristics of each product, such as viscosity and curing time.
- Emulsions are not compatible with cutbacks or paving grades.
- Even small amounts of a cutbacks or paving grades in an emulsion will result in slugs of asphalt, which can cause pumping problems and plugged snivies.
- If emulsion remains in a tank, putting hot cutbacks or paving grades in on top can cause the mixture to foam and boil over because of the rapid expansion of the retained water.
- Generally, cationic (+) and anionic (-) emulsions are not compatible. Their mixture will cause the emulsion to break and become unusable.
- Therefore, to prepare tanks or equipment for alternate uses with emulsions, paving grades, or cutbacks, they should be drained and thoroughly flushed with a petroleum solvent. The "flushing" solvent should be drained before refilling the tank.





TYPES AND SIZES OF ROCK FOR SEAL COAT COVER AGGREGATE

Seal coats are constructed with a variety of chip (rock) sizes, shapes, and gradings. Several factors influence the choice of seal rock.

SURFACE TEXTURE

The desired surface texture can be obtained by using a maximum size of 3/4" or 1/2" for coarse texture and 3/8"or 1/4" for finer texture.

VOLUME OF TRAFFIC

The volume of traffic can influence the aggregate size choice. High traffic volume conditions favor the use of a smaller sized rock, which is easier to stick and less likely to break windshields and headlights.

ECONOMICS OR AVAILABILITY

Economics or availability can dictate the use of aggregates with more fines.

UNIFORM APPEARANCE

Uniform appearance and the best nonskid characteristics are obtained with an aggregate with few fines. The removal of the fines fraction (usually 1/4"-0) from the chips results in a uniform mosaic surface.

TURNING OF COVER STONE

A choke stone can help prevent the cover stone from turning over on a new seal under early traffic.

DURABILITY OF A SEAL

The durability of a seal is affected by the hardness of the seal rock. It is desirable to have a rock which will not crush or degrade under initial construction or later traffic.

CRUSHED OR NATURAL ROCK

Both crushed rock and natural gravel rock are used. The uncrushed (natural) rock is generally less expensive than crushed. With its rounded faces, it has less surface area in contact with old pavement surface and asphalt, thus it is more easily displaced under traffic. Generally, it requires more asphalt to hold it. Therefore, a crushed, well-graded aggregate is preferred.

ONE-SIZED ROCK

A one-sized rock surface produces a uniform mosaic surface. However, without the finer rock matrix, the one-sized rock has a tendency to turn (roll) under traffic. A choke stone applied after the rolling, but before the seal is opened to traffic, can prevent this rock displacement.

DUST AND MOISTURE

The cover aggregate for a seal coat should not have a dust coat. Better results are obtained if the rock is damp when it is applied. The aggregate should be dampened in the stock pile.

APPLICATION RATES FOR ASPHALT AND ROCK

GUIDE TO APPLICATION RATES

The Washington State Department of Transportation's 1987 Standard Specifications contains a guide to application rate ranges.

	Application Rate		
	Asphalt		Aggregates
	(Gal. per sq. yd) Applied		(Lbs. per sq. yd.) Applied
Class A			
Prime Coat	0.40-0.50	3/4"-1/2"	30-40
Tack Coat	0.35-0.50	1/2"-1/4"	25-30
		1/4"-0	4-6
Class B	0.40-0.55	5/8"-1/4"	25-40
		1/4"-0	4-6
Class C	0.40-0.50	1/2"-1/4"	25-30
		1/4"-0	4-6
Class D	0.20-0.35	3/8"-#10	18-25
PreSeal	0.15-0.20	1/4"-0	8-15

ASPHALT

Several basic factors affect the application rate. The amount to apply depends on:

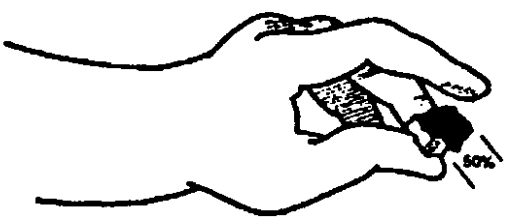
- the size of the rock used for the cover aggregate;
- the grading of the rock:
  - finer graded aggregates require less asphalt,
  - open graded or one-sized aggregates need a heavier shot of asphalt;
- the surface texture of the existing pavement; and
- traffic volumes and seasonal temperature ranges.
  - The asphalt application rate is increased slightly for roads with lower traffic volumes and in areas that have cooler summers.

Other factors may require adjusting the application rates of the asphalt.

- Usually an increase in rates is required for
  - low air or pavement temperatures,
  - pavements in heavily shaded areas,
  - recently patched areas, and
  - open or dry pavements.
- Shots are reduced for fat or flushing pavements.
- Asphalt emulsions will be applied at higher rates than cutbacks under the same conditions. Some feel this is an advantage.

METHODS FOR DETERMINING ASPHALT APPLICATION RATE

The most common way to determine the amount of asphalt to apply is to use past experience. There is a simple test to determine if the application rate used is correct. After the seal coat has been completed (preferably within a day or two), remove a random sampling of the largest sized rocks from the newly completed seal and determine the embedment of rock into the asphalt. An embedment of 50 percent to 70 percent is desirable.



Not enough

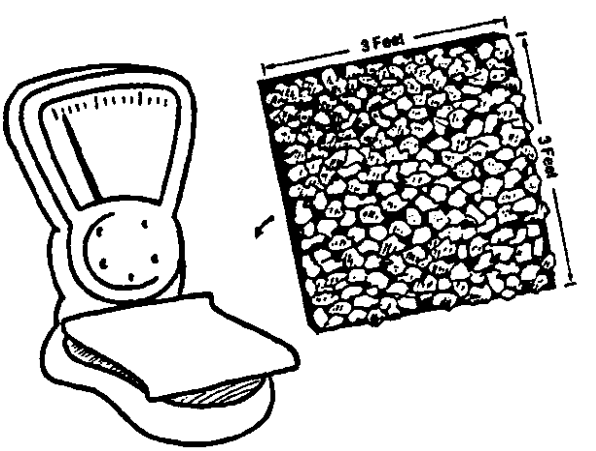
Just right

Too much

AMOUNT OF AGGREGATE COVER

There are several methods of determining the proper amount of cover aggregate.

- The spread rate can be based on experience.
- A simple method to determine the application rate for a specific rock is by laying the rock one stone deep, on a one-square-yard surface, and then weighing it.
- The proper rock cover is when 10 percent to 15 percent black (asphalt) can be seen through the newly laid rock.
- Enough cover aggregate should be spread to prevent pickup under traffic.
- There should not be a surplus of rock on the shoulders, after the surface has been broomed and is being used by traffic.



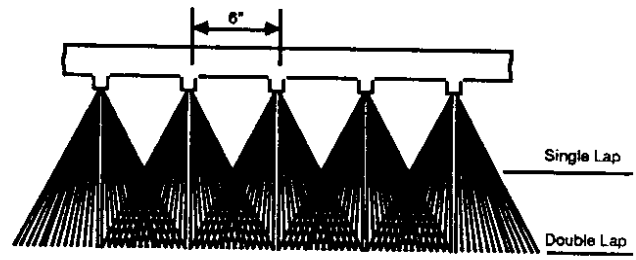
EQUIPMENT FOR APPLYING THE ASPHALT AND THE ROCK

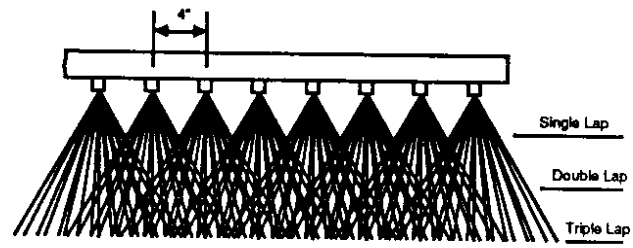
The equipment required to do a seal includes a distributor, chip spreader, trucks, roller(s), and hand tools (broom, shovels, and flagger tools). A second chip spreader or a winter sander to apply the choke, a power broom, and a pilot car are optional but desirable equipment.

DISTRIBUTOR

It is most important that the distributor be properly adjusted and operated to uniformly apply the proper amount of asphalt.

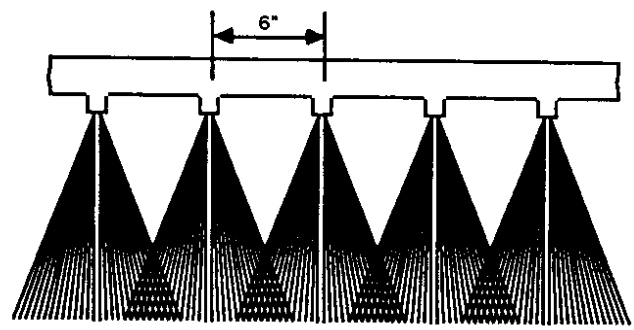
The bar and its snivies (nozzles) must be properly set to obtain a uniform shot (application). The snivy size, spacing, and angle in relation to the bar determine the height of the bar.



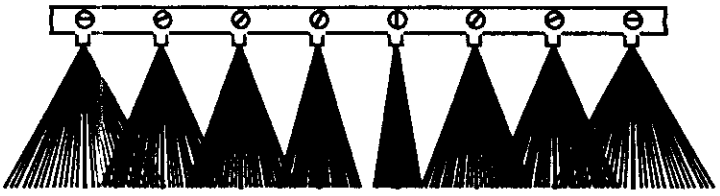


Streaking will occur

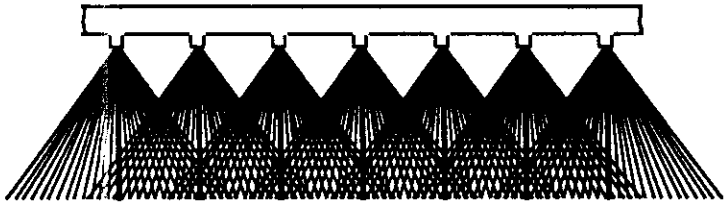
- if the asphalt is too cold;
- when the viscosity of the asphalt is too high;



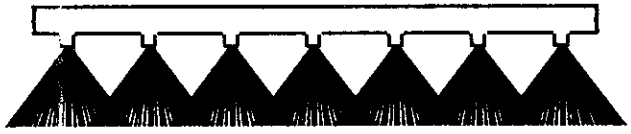
- if the snivies are not all at the same angle;



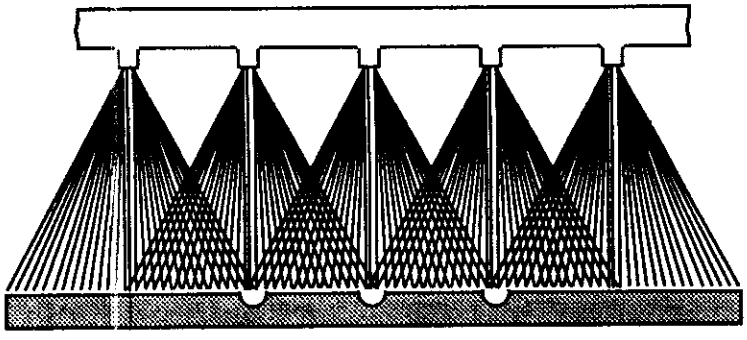
- when the bar is too high;



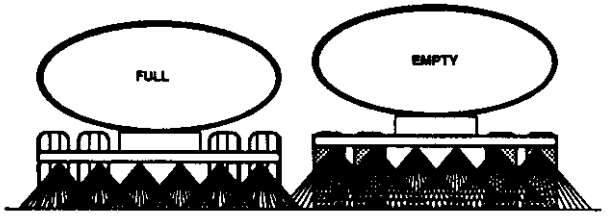
- when the bar is too low;



- when the bar pressure is too high. It cuts furrows because the snivies are too small and/or there is too much pump pressure.



- When the bar varies in height from a full to an empty distributor, blocking or locking against the overload springs will reduce or eliminate this variance in height.
- When the bar is too long and/or the snivy openings are too large for the pump capacity, this results in narrow and fluttering fans. Smaller snivies and/or higher pump capacity will correct this.
- If the pump pressure is too low it will create narrower spray fans and fluttering.
- If the distributor tank is allowed to run completely empty, an irregular pattern of misses and fluttering will occur across the bar. For this reason, the shot should be terminated while approximately 100 gallons are left in the distributor.

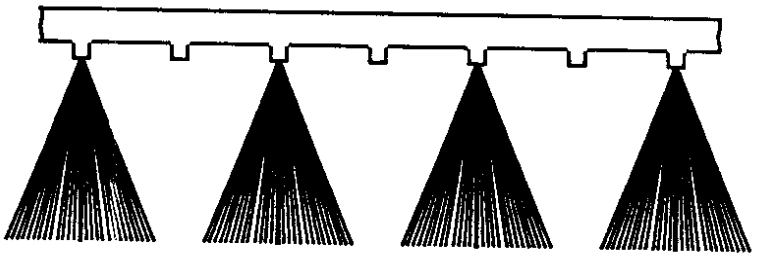


PROPER BAR HEIGHT

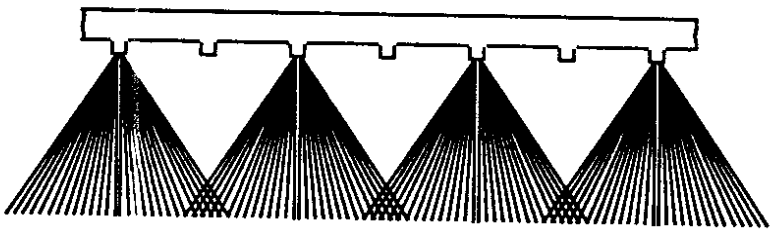
To determine proper bar height,

- make sure the asphalt is at the proper temperature;
- install the right sized snivies;
- make sure the snivies are at the proper angle;
- set the proper pump pressure (or output);
- cut off (turn off) the snivies to produce a single lap, every other snivy for 6" spacing and two snivies for every three with 4" spacing;

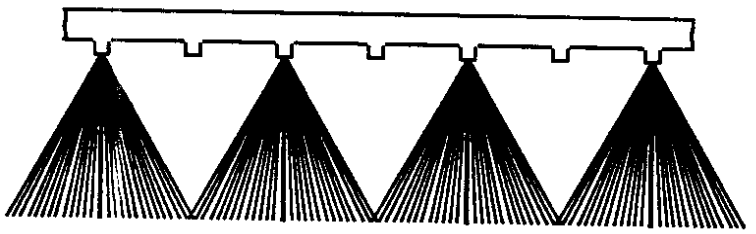
- if the bar is too low, there will be white streaks (areas of no asphalt coverage);



- if the bar is too high, black (double application) streaks will appear.



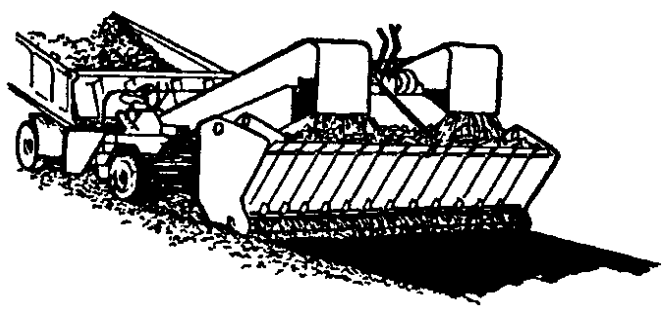
This is perfect coverage. Then turn on the remaining snivies and shot.



CHIP SPREADER

The chip spreader should be checked.

- The gates should be adjusted to apply a uniform rock spread. However, frequently the gates in line with the wheel path of the spreader will be opened slightly more to give a heavier cover in these areas. This is the area of the greatest initial wheel loading. A slightly heavier aggregate cover prevents pick up on the wheels of the chip spreader and aggregate trucks.
- The auger roller in the aggregate hopper should not be bent or out of round. This can cause corrugations.



COORDINATION OF THE OPERATION

PRE-APPLICATION PREPARATION

All equipment necessary for the project should be on the site before the seal coat begins.

There should be enough loaded aggregate trucks standing by to cover the length of the asphalt spread (or the spread should be shortened for the amount of rock available).

The distributor may shoot the lane with traffic or in the the lane opposing traffic. Both have proven satisfactory.

Consider whether to seal toward the stock pile site or away from it. There are advantages and disadvantages to each. Most engineers prefer to shoot toward the stock pile. This keeps most of the construction traffic off the fresh seal and avoids damage to the newly laid surface.

The surface to be sealed should be properly prepared (patched and cleaned).

APPLICATION OF THE ASPHALT

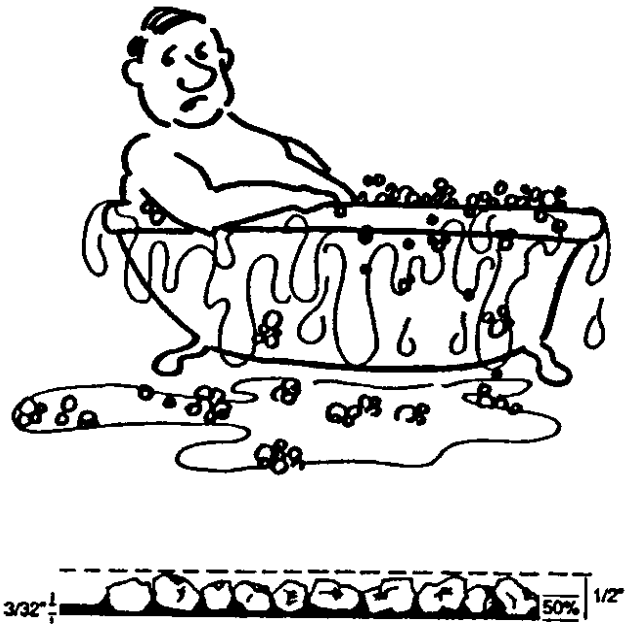
The distributor should start and finish each shot on paper. This assures a uniform application of asphalt for the entire shot.

The shot plan should be adjusted so the longitudinal joint (meet-line) is on the center line or in the center or edge of the driving lanes.

After each shot, the distance, the width, and the amount of asphalt should be determined. From this, the gallons per square yard should be calculated to assure that the proper application rate has been met.

APPLICATION OF THE ROCK

The rock application should follow as rapidly as possible, preferably within three minutes. The asphalt will never be as fluid as when it first leaves the distributor. The asphalt must be fluid so the rock will be embedded by the displacement of the asphalt. This displacement is similar to the rise in the water level when a person sits down in a bathtub full of water. For example, a 0.5 gallon/square yard shot is only 3/32" thick. It is necessary to displace the asphalt while it is fluid to get the desired 50 percent to 70 percent embedment.



A "wave" of asphalt can form in front of the rock spread when a fine graded aggregate is being laid on an emulsion. This is not desirable because transverse ridges may form and affect the ride and appearance of the seal. A slight delay of a minute or so in covering or a reduction in shot rate will reduce or eliminate the "wave." The delay in covering is preferable. As the temperature increases during the day, this waiting period can usually be reduced or may become unnecessary.

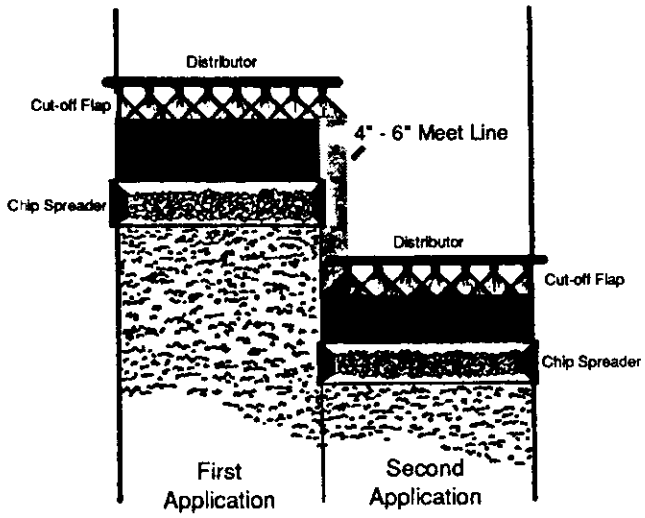
Trucks must back into the spreader. They should break the track (not all travel in the same wheel path) to accomplish some initial rolling. The trucks should not cross over any exposed asphalt such as the open meet line going into the chip spreader. It may be necessary for them to cross over the meet line as they leave the chip spreader.

The speeds and loads of the trucks hauling the seal rock should be regulated to prevent damage to the new seal. They should turn around as little as possible on the new seal.

The chip spreader should be operated at a speed that will prevent the cover aggregate from being rolled as it is being applied. Abrupt stops and starts should be avoided. The aggregate supply should be controlled to assure a uniform distribution across the entire box, so no section in the hopper is "starved" for rock.

The aggregate should be spread on the first half of the roadway so that a 4" to 6" strip of asphalt is left exposed along the centerline. This will form a lap for the application of the asphalt on the second half of the roadway.

If an excess of aggregate has been spread in some areas, it should be uniformly distributed on the adjacent roadway surface or picked up. Areas that have received an aggregate cover that is too light should be hand-spotted (hand-covered).



CHOKE

A dry choke cover is a sand or 1/4"-0. It is frequently used to prevent a new seal coat rock from being turned under early traffic.

The choke is applied after the seal rock has been rolled but preferably before traffic is allowed to use the road. It is applied at the rate of 4 lbs to 6 lbs per square yard. It is better if the choke is rolled before traffic is allowed on the surface but not entirely necessary.

The choke cover usually produces a tighter seal coat surface.

Before rolling

After rolling and traffic

ROLLING

Steel wheeled rollers are frequently used on the prime (the seal on a new base). Pneumatic rollers are preferred for rolling seal coats laid on existing pavements because they will not fracture the rock and will roll into the depressions. Rolling of a seal coat is done to orient the rock (get the flat sides down).

Rollers should be operated at slow speeds (4 to 6 mph) so the rock is set, not displaced.

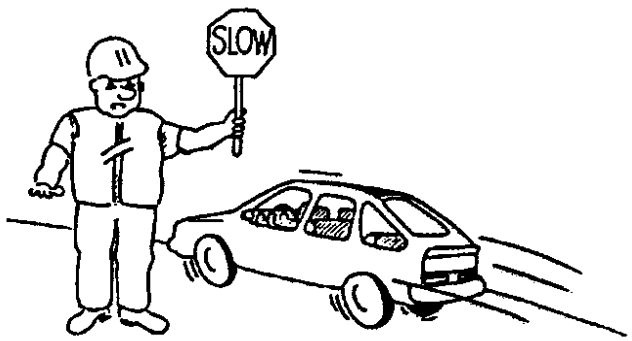
The number of rollers required for a seal coat project depends on the spread of the operation. It takes two to four passes of the roller to set the rock. These

rollers should have tire pressures of 45 psi or more.

APPLICATION OF THE SECOND LANE

After the first lane has been shot, covered, and the rolling has begun, the equipment is pulled back for the second lane. The operation is the same as on the first shot. The open meet line of the asphalt should receive a second shot.

TRAFFIC CONTROL



Even the faster curing asphalts used for seal coats have a tender period. Some form of traffic control is desirable to keep the initial traffic speed below 25 mph. Flaggers or signs help, but the most positive means is a pilot car. The primary purpose of the pilot car is to control the speed of the traffic through the project. In addition, the pilot car can move traffic back and forth across the roads to prevent travelling in the same wheel paths. This traffic will supply some secondary pneumatic tired rolling.

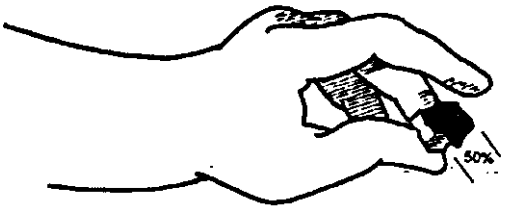
BROOMING

Brooming is done at the completion of the seal coat process for the following reasons:

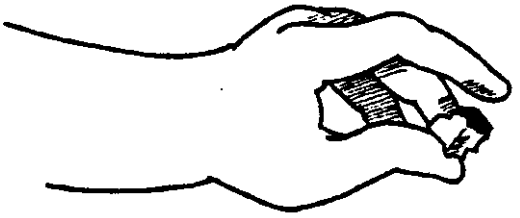
- When a cutback is used, there may be an advantage to bringing the loose cover stone from the shoulder area back onto the newly sealed surface. It is possible an additional amount of rock can be stuck. This procedure can serve as a blotter for areas that may blacken or bleed. This brooming is generally done with a broom ("turkey tail") on the moldboard of a motor patrol.
- Removal of the surplus aggregate from the surface of a new seal coat will reduce flying rock, which can break windshields and headlights. This loose surplus aggregate can grind and loosen some of the rock set in the seal coat. Brooming can be done the next day or several weeks later, depending on traffic and the curing characteristics of the asphalt used. It is desirable to broom during the cool period of the day (early morning). If the rock is being dislodged, the brooming should be delayed until the asphalt has cured further or the weather is cooler. A rotary power broom is generally used. The gutter broom on a pick-up sweeper should not be used because it can exert such severe brooming action.

POST-SEAL INSPECTION

The embedment of the aggregate into the asphalt should be checked a day or so after the construction of the seal coat. Remove several of the largest stones and determine if the 50 percent to 70 percent embedment has been obtained.



If an inadequate application of asphalt was applied, a fog seal can enrich and tie down the seal rock. A diluted CSS-1 (usually 50/50) is applied at the rate of .1 to .2 gallons per square yard of the dilution. (Application can vary depending on pavement texture, local conditions, and traffic.) No cover aggregate is required; however, if a tighter seal is desired, a sand or 1/4"-0 cover may follow. Traffic should be controlled until the CSS-1 has cured.



MISCELLANEOUS SEAL COAT INFORMATION

ASPHALT ADDITIVES FOR SEAL COAT ASPHALTS

Anti-Strip Additives

Some aggregates have a strong electro-chemical make-up and tend to repel the asphalt, particularly in the presence of water. Under these conditions, the asphalt strips from the rock and the rock loses its bond. This is where the ant-strip additive may prove beneficial, particularly for paving grades and cut-backs. Most of the emulsifiers in asphalt emulsions are an anti-strip additive. A rather simple laboratory test such as AASHTO T-182(ASTM D1664) can indicate the need for an anti-strip additive.

Polymers

A polymer can be blended with an asphalt to alter the physical characteristics of the asphalt. It must be an individual decision as to the need, benefits, and additional cost justification of the polymer.

MARKING CENTER LINES

Marking centerlines before applying a seal coat can save the cost of re-engineering the location of the centerline. These markers can serve as a temporary centerline. The two most popular markers are

- the polypropylene "stake chaser," and
- the stick-on reflectorized stand-up tabs.

SEASONAL PROTECTION SEAL COATS

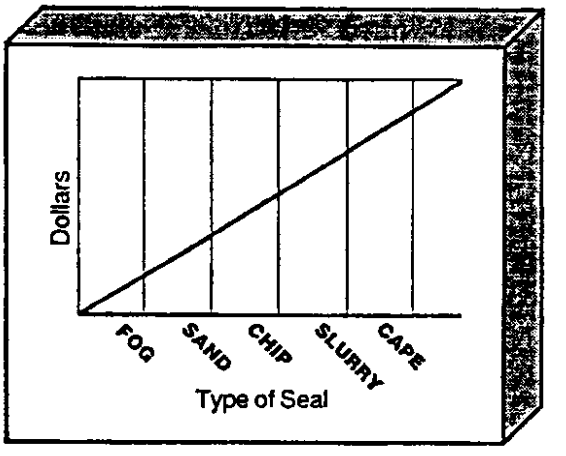
Seal coats, as with all asphalt pavements, should be protected during the time of year when bases are weakened. This weakness occurs when frost is coming out. Weight restrictions should be posted as necessary and enforced to preserve the seal coat surface.

Excessive pressure applied to the plow blade during snow removal can result in the loss of seal coat rock.

RELATIVE COST

The relative cost of the various seal treatments from the least to the most expensive are as follows:

- the fog seal (construction seal),
- the sand seal,
- the chip seal,
- the slurry seal, and
- the cape seal, which combines the cost of a chip and a slurry seal.



Costs of Various Seals

GLOSSARY

Breaking emulsions	the separation of the asphalt and water, which generally makes the emulsion unusable.
Breaking track	when vehicles do not travel in the same wheel path.
Choke	a sand or manufactured 1/4"-0 that is applied after the primary cover stone to fill surface voids, to prevent rock turning, and to serve as a blotter.
Coke	carbon formed by overheating of the asphalt.
Cutter	a petroleum solvent.
Float	loose cover stone on a granular base.
Hand-spotted	hand-covered.
Inverted penetration	penetration that is upward into the cover stone.
Matrix	the fine aggregates surrounding the larger rock in the asphalt mix.
Meet line	the exposed asphalt strip left uncovered along the center line on the first half of the seal.
Naphtha	a type of gasoline.
Prime coat	an application of asphalt on an untreated or granular surface.
Pre seal	a fog seal to tighten a surface before a seal coat.
Slugs in asphalt	pieces of semi-solid asphalt.
Snivy	the spray nozzle on an asphalt distributor.

Stripping	when asphalt loses its bond with the seal coat aggregate.
Tack coat	a light application of asphalt between an existing pavement and an overlay. It can also be second shot on a bituminous surface treatment.
Tacky	sticky.
Viscosity	the degree of fluidity.

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