

Dust Control on Unpaved Roads

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INTRODUCTION

Dust on unpaved roads creates a number of problems, all of which can be placed into three groups: (1) nuisance, (2) safety hazard, and (3) loss of road materials. The nuisance and safety hazard are causes for many complaints about dusty roads. The loss of road materials, in the form of dust, represents a significant economic loss.

Studies in Indiana and Michigan indicate the yearly loss of road materials averaged about 45 cu yd. per mile of 18 ft roadway on roads with a traffic volume of 100 vehicles a day. Three times this traffic can cause a yearly loss of 135 cu yd. of material. At a replacement cost of at least one dollar per cubic yard, this loss represents a costly item of maintenance. It is reported that dust palliative treatments can reduce these losses as much as one-half.

Dust palliatives are a temporary cure; and therefore, large expenditures for these materials year after year are not recommended. Temporary dust cures are often justified, but it should be recognized this maintenance expense reduces the funds available for more permanent road surfaces or more substantial steps of stage construction.

This bulletin presents information on use, application and costs of dust-laying materials commonly used in Indiana; namely, calcium chloride and bituminous materials.

WHEN TO USE DUST PALLIATIVES

The use of dust-laying materials on extremely dusty roads can be justified under the following conditions: (a) when the traffic volume is high enough to warrant a permanent type surface but funds are not immediately available to construct this surface; and (b) when the dust constitutes an extreme nuisance, safety hazard or soil-aggregate loss even though the traffic volume may not be high.

The severity of a dust problem is primarily a function of the amount and speed of traffic on an unpaved road. When the traffic volume is

about 0 to 50 vehicles a day, the dust condition is rarely serious enough to require the use of a dust palliative. For 50 to 100 vehicles a day, and when there are a substantial number of complaints or a safety hazard exists, the use of spot treatments may be warranted.

Spot treating involves the spreading of a dust palliative for a distance of approximately several hundred feet in front of residences, schools, churches, markets, factories, road intersections, railroad crossings and bridges. Some county highway departments spot treat in front of homes or places of business only if the resident or owner pays for the dust palliative material. Other counties may charge for both material and labor. The majority of the counties, however, make no charge but tend to keep spot treating to a minimum.

When the count is somewhere between 100 to 300 vehicles a day; not only is there a nuisance condition and safety hazard, but there is also a significant loss of road materials. In this case, the use of strip or full-width dust treatments can often be justified on the basis of a reduction in maintenance costs. A strip treatment is the application of a dust palliative to a strip 8 or 10 feet wide down the center of the road. Strip treating is satisfactory when traffic is not heavy enough to require regular use of two driving lanes.

For roads with over 300 vehicles a day, a permanent type surface is usually warranted. However, if funds are not immediately available for this surface, the use of a full-width dust treatment may be justified for one to several years until funds do become available.

When an unpaved road lacks gravel, composed primarily of silt-clay, and is very dusty, consider the possibility of adding aggregate as a means of reducing the severity of the dust. The amount of dust reduction may be small; however, the added gravel will also serve as a step in stage construction when the same grade and alignment can be held for future developments. How much gravel can be purchased for the anticipated dust palliative treatment?

HOW TO USE DUST PALLIATIVES

PREPARATION OF THE ROAD SURFACE

Well-shaped crowns and adequate ditches are vital for rapid surface drainage and for retaining the dust palliative on the road the maximum length of time. The crown should have the shape of an inverted "V" sloping downward from the center at an approximate rate of $\frac{1}{2}$ inch per foot. Shaping is best done in the late spring. When the

road is too wet, it will not hold its shape; and when too dry, shaping is difficult, and the loose material does not recompact properly.

It is better to apply a dust palliative just before the formation of dust begins rather than after a layer has accumulated. Application of a dust palliative to a layer of dust and fine loose material causes the formation of a crust. The crust breaks up under traffic and the effectiveness of the dust palliative is quickly lost. When the dust is over about 1/16 inch thick, consider the merits and costs of either sprinkling with water or blading before applying the dust palliative.

Application of dust palliatives is best done when the roadbed is slightly damp. In the case of calcium chloride, the moisture hastens solution so that there is less chance of the chemical being whipped or blown off the road. Even in the use of bituminous materials, penetration is faster and more uniform on a damp road than on a very dry one.

Before applying a dust palliative, check the weather reports. Rain, heavy enough to cause run-off, is undesirable for at least 36 hours after application.

APPLICATION OF DUST TREATMENTS

In Indiana, calcium chloride and bituminous materials have been widely used for dust palliative treatments. The calcium chloride is commonly applied in a dry flake or pellet form; however, in recent years, the practice in other states has pointed up certain advantages to using calcium chloride applied to the road in a liquid form. In the case of bituminous materials, liquid grades applied to the roadway from pressure distributors have been the most common method of application. Calcium chloride and bituminous materials may be purchased by the county highway department and applied by the county highway forces. Both of these dust treatment materials may also be applied to the roadway by the supplier. He will furnish materials, equipment, and labor to make dust treatments on designated roads. Both methods of purchasing have certain advantages which should be considered if an extensive dust-treatment program is being planned.

SUMMER MAINTENANCE OF DUST-TREATED ROADS

During summer, blading of dust-treated roads should be kept to a minimum to prevent an uneven distribution of the dust treatment. Manipulation also creates fines which tend to saturate or overload

the capacity of the dust palliative. Fortunately, effective dust applications reduce the number of bladings required.

When blading is necessary, it is best done after a rain or sprinkling. An alternate time is early in the morning while the road is still damp. Short sections should be worked so that compaction can be achieved before drying occurs. Blading direction should be from the road-edge or shoulder toward the centerline and back out toward the edge.

DUST CONTROL WITH CALCIUM CHLORIDE TYPES AND GENERAL APPLICATION METHODS

Two types of calcium chloride available for dust laying are Type I, the regular flake form; and Type II, a more concentrated material. A pellet form of Type II is replacing Type I for use on roads as a dust palliative. The advantages of using Type II compared to using Type I are: (1) less chemical required; (2) lower shipping costs; (3) less handling and storage; (4) less tendency to cake or become sticky in shipping and storage; and (5) better flow characteristics or conveyance of bulk material.

ACTION ON VARIOUS ROAD SURFACES

Calcium chloride has the ability to draw moisture from the air and to completely dissolve itself in this moisture. Since the moisture content of a treated road is increased, the chemical is most effective on those unpaved roads containing a certain amount of clayey binder. The added moisture increases the cohesiveness of the clay and aids in compaction of the soil-aggregate road. Calcium chloride is also effective as a dust palliative on silt-clay roads.

Roads containing a large amount of a plastic clay and which are known to become slippery with rain, will become even more slippery after calcium chloride has been applied to the surface. When calcium chloride is to be placed on a road that sometime before has been oiled, care should be taken not to put the chemical on spots of unabsorbed oil. The moisture attracted to the surface of these spots by the dust palliative can make them slippery.

Calcium chloride is least effective on roads with a large amount of loose granular material. Loose float material lacks cohesion and permits faster leaching or washing out of the calcium chloride.

APPLICATION OF DRY CALCIUM CHLORIDE

How much chemical should be applied per square yard or mile and how many applications a season are required? The first applica-

tion generally ranges from 0.8 to 1.2 lb. per sq. yd. of Type II calcium chloride (1 to 1.5 lb. Type I). Subsequent applications may range from 0.4 to 0.8 lb. per sq. yd. of Type II (0.5 to 1 lb. of Type I). Two applications a season is more common than three. The section on "How to use Dust Palliatives" contains information on road preparation.

Factors which tend to increase the required amount of calcium chloride are: (1) high traffic volume; (2) long, hot, dry periods; and (3) accumulations of loose dust.

The proper rate of application for specific roads is undoubtedly best learned through experience. The relation of current material costs to the rate of application is shown in Table 1. After deciding on the rate, width and length of each application, the total amount of required calcium chloride, in tons or bags, can be computed from Tables 1 through 5 on the following pages.

Table 1
APPLICATION RATES OF DRY CALCIUM CHLORIDE
TYPES I AND II

Type I				Type II			
Width of Road in Feet	Lbs. per Sq. Yd.	Lin. Ft. per 100 Lb. Bag	Tons per Mile	Width of Road in Feet	Lbs. per Sq. Yd.	Lin. Ft. per 80 Lb. Bag	Tons per Mile
8	.5	225	1.17	8	.4	225	.96
	1.0	112	2.35		.8	112	1.92
	1.25	90	2.93		1.0	90	2.40
	1.5	75	3.52		1.2	75	2.88
9	.5	200	1.32	9	.4	200	1.08
	1.0	100	2.64		.8	100	2.16
	1.25	80	3.30		1.0	80	2.70
	1.5	67	3.96		1.2	67	3.24
10	.5	180	1.47	10	.4	180	1.20
	1.0	90	2.93		.8	90	2.40
	1.25	72	3.67		1.0	72	3.01
	1.5	60	4.40		1.2	60	3.60
12	.5	150	1.76	12	.4	150	1.44
	1.0	75	3.52		.8	75	2.88
	1.25	60	4.40		1.0	60	3.60
	1.5	50	5.28		1.2	50	4.32
14	.5	129	2.05	14	.4	129	1.68
	1.0	64	4.11		.8	64	3.37
	1.25	51	5.13		1.0	51	4.20
	1.5	43	6.16		1.2	43	5.05
16	.5	112	2.35	16	.4	112	1.92
	1.0	56	4.69		.8	56	3.84
	1.25	45	5.87		1.0	45	4.81
	1.5	37	7.04		1.2	37	5.77
18	.5	100	2.64	18	.4	100	2.16
	1.0	50	5.28		.8	50	4.32
	1.25	40	6.60		1.0	40	5.41
	1.5	33	7.92		1.2	33	6.49
20	.5	90	2.93	20	.4	90	2.40
	1.0	45	5.87		.8	45	4.81
	1.25	36	7.33		1.0	36	6.00
	1.5	30	8.80		1.2	30	7.21

Note: To determine the number of 100-lb. bags per mile, multiply the figure in Tons per Mile column by 20.

Note: To determine the number of 80-lb. bags per mile, multiply the figure in Tons per Mile column by 25.

SPREADING EQUIPMENT

Equipment used for spreading dry calcium chloride includes: (1) common drill units; (2) spinner disc units; and (3) positive displacement units. For extensive work, the use of spinner disc or positive displacement equipment to spread bulk calcium chloride is the most efficient spreading method. Spinner disc and positive displacement units also have an advantage in that they can be used the year around for spreading salt, cinders, sand and chips.

Positive displacement units contain a horizontal roller with short fins to provide a positive and uniform feed. The width of spread is 7 to 8 feet. Some spinner disc units are capable of spreading materials over a 20-foot width in a single pass. Both types of equipment can be mounted on trailers or on the rear of dump bodies of trucks.

The drill is usually 8 feet wide, but the width of spread can be varied by placing a board over the top of the drill holes. A baffle board, about 10 inches wide, placed below the drill holes, will produce a uniform spread of calcium chloride on the road surface by preventing ridging.

After each use, wash or rinse the spreading equipment. Otherwise the calcium chloride will attract moisture to the metal and promote rusting.

CALCIUM CHLORIDE SOLUTION AND ITS PREPARATION

When the weather is extremely dry and distributor trucks are available, it may be desirable to spray a calcium chloride solution. Results are immediate, and the evaporation of the water is retarded by the calcium chloride. However, the application of excessive amounts of calcium chloride will produce a muddy condition and a loss of material through run-off.

A 34 per cent solution is commonly used for dust laying. The solution is most often mixed in the distributor. Mixing containers and pipes should be capable of withstanding temperatures of 225 degrees F. Workmen should be cautioned about the high temperatures that develop during mixing.

The 34 per cent solutions are formed by mixing 4 lb. of Type II calcium chloride (or 5 lb. Type I) per gallon of water. When 1000 lb. of Type II is added to 220 gal. of water, 255 gal. of solution is obtained. One thousand pounds of Type I plus 155 gal. water yields 205 gal. of solution.

Mixing is performed as follows. Fill the tank to the desired *water level*. Measure by stick gage, meter or weighing. Use a recirculating pump (minimum capacity of 220 gpm) and start circulating the water before adding the calcium chloride. Add the chemical until the proper *level of solution* is obtained. A volume measurement of this type will eliminate the need for weighing the calcium chloride. The solution should be circulated until all the chemical has dissolved.

When mixing large amounts of solution for the first time, it is advisable to have experienced men handle the operation.

APPLICATION OF CALCIUM CHLORIDE SOLUTIONS

Preparation of the road to receive an application of solution has been discussed previously. Calcium chloride in solution can be applied so that the comparable dry rates of application can be obtained. These range from 0.5 to 1.5 lb. per sq. yd. for Type I and 0.4 to 1.2 lb. per sq. yd. for Type II.

Very tight surfaces will be able to take only a minimum amount of solution on the first spraying. In contrast, loose, open, coarse surfaces can take larger amounts. In order to apply the desired amount of calcium chloride to the surface, a number of light sprayings may have to be made in place of a single large one.

Table 2 below shows that 0.1 gal. of a 34 per cent solution will deposit 0.4 lb. of Type II calcium chloride on 1 sq. yd. of road surface. Two-tenths of a gallon will deposit 0.8 lb. of chemical, etc.

Table 2
APPLICATION RATES FOR 34 PER CENT
CALCIUM CHLORIDE SOLUTIONS

Width of Spread	8 Feet			9 Feet			10 Feet		
Sq. yds. per lin. ft.	0.89			1.00			1.11		
Dry Type II Equiv.	0.4	0.8	1.2	0.4	0.8	1.2	0.4	0.8	1.2
Gals. per sq. yd.	0.10	0.20	0.30	0.10	0.20	0.30	0.10	0.20	0.30
Gals. per lin. ft.	0.09	0.18	0.27	0.10	0.20	0.30	0.11	0.22	0.33
Gals. per mile	470	940	1410	528	1056	1584	586	1172	1758

DISTRIBUTORS FOR SOLUTION

Pressure distributors should be used for spraying calcium chloride solutions in order to obtain a uniform application. Liquid bituminous distributors can be used, but such elaborate equipment is not required.

The inside of the tank (about 1000 gal. minimum capacity), should be coated with a rust preventive and all piping should be iron. The pumping system should be able to recirculate the solution. Use a pressure regulating valve to obtain desired pressures and a pressure gage, visible to the driver, to show the pressure at the spray bar. The spray bar should be fitted with appropriate nozzles and mounted close to the road. Use a fifth-wheel tachometer to measure the truck speed in feet per minute.

COSTS

In 1957, it was reported that the cost of treating one mile of 18 ft. roadway with dry calcium chloride was about \$500 a mile. The cost included material and application costs for three applications of Type II calcium chloride at application rates of 0.8, 0.4 and 0.4 lb. per sq. yd.

To determine the total costs of a calcium chloride dust palliative treatment, include material costs, shipping costs, spreading costs and overhead. The f.o.b. plant costs of the chemical as of March 1960 are given in Table 3. Material costs for treating one mile of 18-ft. roadway for various rates of application are given in Table 4.

Table 3
COSTS OF CALCIUM CHLORIDE F.O.B. PLANT, MARCH, 1960

Calcium Chloride	Per Ton in 100 lb. Bags	Per Ton in 80 lb. Bags	Per Ton in Bulk
Type I	\$32.00	\$26.00
Type II	\$39.80	32.00

Shipping costs in Indiana, range from about 5 to 10 dollars a ton. Since it takes 20 per cent less Type II than Type I for dust laying, a 20 per cent savings in shipping costs can be realized by using Type II chemical. Spreading costs range from 2 to 12 dollars a ton. In large scale programs, costs can be kept to a minimum by using bulk calcium chloride, conveyors for loading and spinner disc or positive displacement units for spreading.

Table 4
COST OF CALCIUM CHLORIDE FOR TREATING ONE MILE OF
18-FOOT ROADWAY FOR VARIOUS RATES OF
DRY APPLICATION, MARCH, 1960

Rate of Application				Cost per Mile for Calcium Chloride**	
Type I		Type II*		Bags (Type I or II)	Bags (Type I or II)
Lb. per Sq. Yd.	Tons per Mi.	Lb. per Sq. Yd.	Tons per Mi.		
.25	1.32	.2	1.06	\$ 42 per mi.	\$ 34 per mi.
.50	2.64	.4	2.11	84	68
.75	3.96	.6	3.18	172	102
1.00	5.28	.8	4.22	168	135
1.25	6.60	1.0	5.30	211	170
1.50	7.92	1.2	6.34	255	205

* Amount equivalent to Type I as a dust palliative.

** Add shipping, spreading and overhead costs to obtain total application cost.

SHIPPING AND STORAGE

Calcium chloride is commonly shipped in moisture-proof bags of 80 and 100 lbs. Bulk material may be also delivered in covered rail-road cars, or covered trucks. The chemical may be rejected if it has become caked or sticky in shipment. When shipping is by rail car, three days is usually the unloading limit without additional demurrage charges.

When storing calcium chloride, it should be enclosed in a dry shelter and kept off the bare ground or concrete flooring and on planking. Bulk material, stored for a period of time, may develop a crust up to one or two inches thick. When this protective crust is removed, the material beneath it may be used satisfactorily.

Partially open, torn, or wet bags should not be kept in storage with undamaged bags. The damaged bags should be set aside and used first. Alternate layers of bags should be laid crosswise in storage. The storage space required for flake calcium chloride in paper bags is approximately 2 cu. ft. per 100 lb. or 40 cu. ft. per ton.

DUST CONTROL WITH BITUMINOUS MATERIALS BITUMINOUS MATERIALS AND THEIR FUNCTION AS DUST PALLIATIVES

Bituminous dust palliatives used most commonly are slow-curing asphalts or road oils, medium-curing asphalts, and emulsified asphalts.

Light grades of tar are used where competitive in cost with asphaltic materials.

Bituminous materials lay dust by means of a cementitious quality and by their ability to wet and coat particles and simply weigh them down. They may be used on all types of soil-aggregate roads.

USE OF BITUMINOUS MATERIALS RELATED TO ROAD SURFACE CONDITIONS

On unpaved roads with tightly bonded surfaces (primarily silt-clay or aggregate roads with a silt-clay binder), the use of bituminous materials with low viscosity (high fluidity) are desirable. Penetration of bituminous dust palliatives improves as the material becomes more fluid. In other words, penetration is faster and more uniform in tight surfaces by bituminous materials with a lower grade number than those with a higher grade number. Materials most suitable for tight surfaces are:

- (1) Slow-curing asphalt (road oil) of grades SC-0 and SC-1,
- (2) Medium-curing asphalt of grade MC-0,
- (3) Emulsified asphalt designated AE-P,
- (4) Tar of grade RT-1.

A few materials of a higher viscosity and grade number, as well as the materials listed above, are suitable for more loose, open, coarse-grained road surfaces. Materials of higher grade number include

SC-2, MC-1 and RT-2.

APPLICATION

For information on road preparation to receive a bituminous dust palliative and for information on summer maintenance, refer to a previous section "How To Use Dust Palliatives."

The amount of bitumen used for dust laying ordinarily ranges from .05 to .25 gal. per sq. yd. No more material should be applied than can be absorbed in about 24 hours. Slightly damp surfaces will absorb more material than very dry surfaces. Open, coarse-grained surfaces can take more bitumen than tight fine-grained surfaces.

Roads with higher traffic volumes usually require more bitumen for effective dust control than roads with lower traffic volumes. Roads treated for the first time tend to require more bitumen than those that have been treated in previous years. Likewise, initial seasonal treatments tend to require more bitumen than treatments applied later in the same season. Bituminous dust palliatives have a cumulative effect.

When the road is dry and hard, it is advisable to first sprinkle with water or to make two light applications instead of one heavier one.

Penetration is improved and run-off is prevented or minimized by these procedures.

SPRAYING TEMPERATURES

Heating bitumens before application improves their wetting, coating and penetration actions. Spraying temperatures for various bituminous products, as recommended by the American Association of State Highway Officials, are given in Table 5. Road oil of grade SC-0 and emulsified asphalt (AE-P) may be applied without heating at normal Indiana summer temperatures.

Table 5
SPRAYING TEMPERATURES FOR BITUMINOUS DUST PALLIATIVES,
RECOMMENDED BY AASHO

Slow-Curing Asphalt	Spray Temp. °F.	Medium-Curing Asphalt	Spray Temp. °F.	Tars	Spray Temp. °F.
SC-0	60-150	MC-0	100-150	RT-1	60-125
SC-1	125-200	MC-1	125-175	RT-2	60-125
SC-2	150-225				

SANDING

When it is desired or necessary to prevent tracking and "pick-up," the road should be sanded, bladed or dragged following application of the bituminous material. Loose material on the side of the road may be lightly bladed over the treated portion of the road. A light sanding consists of about 5 to 10 lb. per sq. yd. of sand. This is equivalent to 26 to 52 tons per mile of 18-ft. roadway. Methods used to prevent tracking will naturally increase the cost of using bituminous materials.

DISTRIBUTORS

All bituminous materials, presently available for use in Indiana, should be applied with a pressure distributor. Pressure distribution gives good control of the rate of application and provides an even application. The pressure distributor should be designed and operated to produce a uniform spray without atomization between the limits of the temperature specified. It should have a fifth-wheel speed tachometer registering feet per minute so that the driver can maintain a constant speed during application of the specified amount. The pump should also be equipped with a tachometer showing the driver the number of gallons per minute passing through the nozzles.

When the distributor has heating attachments, it should also have facilities to circulate or agitate the liquid during the entire heating process. A thermometer should be placed away from the heating tube so as to indicate the temperature of the bituminous material at all times. The width of application should be at least six feet.

COSTS

Cost of bitumens listed herein ranges from about 12 to 15 cents a gallon f.o.b. refinery. Cost of applying the materials by the supplier is about 3 to 5 cents a gallon. This includes supplying, heating (when required) and application of the materials to the road with a pressure distributor. Table 6 shows cost of treating 1 mile of 18-ft. roadway over its entire width (10,560 sq. yd.) for various rates of application and various costs per gallon of the applied material.

Table 6
COST IN DOLLARS PER MILE FOR TREATING AN 18-FOOT
ROADWAY WITH BITUMINOUS MATERIALS*

Rate, in Gal. per Sq. Yd.	Cost in Cents per Gallon of Bituminous Dust Palliatives, Applied					
	15¢	16¢	17¢	18¢	19¢	20¢
0.1	\$158	\$169	\$180	\$190	\$201	\$211
0.2	317	338	359	380	401	422
0.3	475	507	539	570	602	634
0.4	634	676	718	760	803	845
0.5	792	845	898	950	1003	1056

* Includes materials and road application but does not include sanding.

After deciding on the rate of application required and the cost per gallon of applied material, one simply reads across from the rate column and downward from the cost figure (cents per gallon, applied) to obtain the cost of treatment for one mile. After one or two years of treatment, the bitumen may accumulate on the road so that subsequent application rates and costs can be reduced.

OTHER DUST PALLIATIVES

There are a number of other dust palliatives that possibly could be used in Indiana. Claims of successful use of each have come from outside the state where conditions, cost and availability are more favorable for their use. These materials are: (1) highly-diluted, slow setting emulsified asphalt (SS-1); (2) proprietary bituminous products sold by some refineries; (3) sulphite liquor, a waste product of paper mills and (4) sodium chloride, including rock salt and the brine.