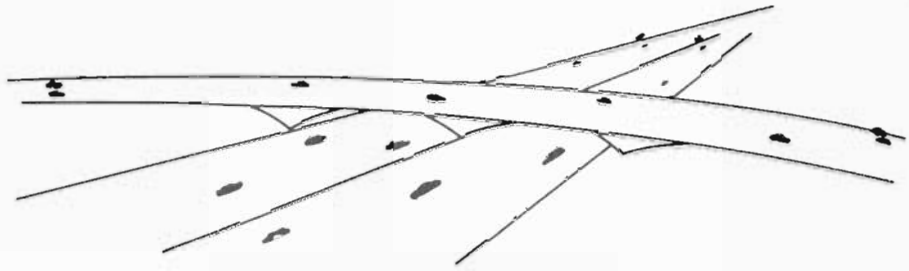

DEPARTMENTAL RESEARCH

Report Number S.S. 20.2

SPRINKLE TREATMENT OF BOTH ASPHALTIC AND PORTLAND CEMENT CONCRETE IN BELGIUM

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

SPRINKLE TREATMENT OF BOTH ASPHALTIC AND PORTLAND CEMENT CONCRETE IN BELGIUM

by

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SUMMARY

Sprinkle treatment, the technique for applying skid resistant stones to the surface of pavements, has been used in Belgium since 1962. The author went to Belgium and observed sprinkle treatment which had been applied to both asphaltic concrete pavements and Portland Cement Concrete pavements. The chronological account has technical information interspersed. Significant data were obtained concerning their mix designs, equipment, and specifications. A comprehensive questionnaire provided the format for a thorough discussion of sprinkle treatment by several of their researchers and the author.

Additionally, three other techniques for improving the skid resistance on Portland Cement Concrete pavement were examined: (1) grooving, (2) stripping, and (3) "waffling".

CONCLUSIONS

1. Sprinkle treatment, of both asphaltic concrete pavement and Portland Cement Concrete pavement, can be an effective and economical method of providing needed skid resistance.
2. Plant precoating of the sprinkle rock is effective but care should be taken to prevent coking of the asphalt.
3. Sprinkle rock can be precoated with AC, and it can be stored in small stockpiles (no more than three feet high) for short periods of time as long as care is taken to prevent contamination.
4. Sprinkle stones can be placed cold with excellent stone retention -- possibly with less expense, less effort and better control.
5. Excellent aggregate spreaders are available in Europe and are necessary for proper distribution of sprinkle stone. Salt or agricultural type distributors are not as satisfactory for placing sprinkle stones.
6. Sprinkle treatment can be effectively placed any time hot mix can be placed.
7. Sprinkle treating Portland Cement Concrete precludes the need for grooving later on.

PART I

On arriving at the Center for Research on Monday, June 28, 1976, Mr. G. Van Heystraeten introduced me to Mr. Fuchs, who is their expert on concrete pavement. He also introduced me to Mr. DeMesmaeker, who assists both Mr. Fuchs and Mr. Decoene, their bitumen expert. He stated that they had some new films on grooving and sprinkle treating that would be shown at the International Skid Resistance Conference.

Mr. Van Heystraeten and Mr. Fuchs explained that they have three methods for achieving good skid resistance and texture on concrete pavements. The first method is deep transverse grooving. They require a minimum polish value of 50 according to British Standard 812, revised in 1975 for the coarse aggregate. The second method is stripping the concrete or removing the mortar. Here again, there is a minimum polish value of 50 on the stone for this concrete. The third method is chipping (sprinkling). Eleven to fifteen pounds of 1/2" to 3/4" stone are used per square meter. The skid resistance is measured from 20 to 80 kilometers per hour. They use 1 to 2 centimeters slump concrete.

At 11:00 a.m., we went to observe grooving which had been in place one year on Motorway B-1 Ring Road around Brussels. They have decided that the best spacing for grooving is 10 millimeters to 30 millimeters (this is covered in a publication which I obtained). They have also decided that transverse grooving is best for reducing splash and spray. We then went to Tienen to see some new concrete which had been stripped of its surficial mortar with a soft brush and water. Next we went to Hasselt to observe chipping operations with chips from Norway. Local material was being used for the concrete. We also went to Herstal where concrete was grooved in 1962. We observed some "waffle" type treatment on concrete, but they stated that the "waffle" type treatment was not as good as transverse grooving.

Tuesday, June 29th. Before leaving to inspect various asphaltic concretes, they described their usual design. It consists of a sand layer over soil, a lean concrete or crushed gravel, a foundation course, and then a wearing course. Wearing courses are either Type 1 unchipped or Type 4 unchipped, 2" and 3" respectively, with 55% plus 10 coarse aggregate. This is what is used on common roads. (Note that in their design, all the stone constituents add up to 100%.

This is different from England's design which includes bitumen in the 100%.) Type 2 asphaltic concrete is used in their chipping operations. Generally, they would not use less than a 1¼" to 1½" mat thickness, nor would they place sprinkle treatment in cold weather. For a thickness of three to four centimeters, they use only 35% coarse aggregate, whereas, for four to five centimeters thickness, they can use 55% coarse aggregate. The maximum allowable axle load in England is nine tons, but in Belgium the maximum allowable axle load is thirteen tons.

There are four grades of sprinkle treatment stones. (1) 1/8" to 1/4" is the smallest grade and it is considered the least desirable. It is too fine and lower skid resistances result. This grade is placed at eleven pounds per square yard. (2) 1/4" to 3/8" is placed at a rate of six pounds per square yard using natural stones with good polish characteristics. This is the most desirable. (3) 3/8" to 1/2" is considered a very good grade but they use nine to fifteen pounds per square yard. This yields more texture and good skid resistance but by using the 1/4" to 3/8" stone, less stone is required. (4) The 1/2" to 5/8" is considered dangerous because of windshield breakage. There is a "flakiness" requirement on the stone used for sprinkling; i.e. the height versus the length cannot be more than 1 over 4. They considered a whiteness requirement for the reflectivity of the pavement which is measured as 50 angstroms according to the German method.

Belgium utilizes a sand patch texture test for concrete, and their requirement is 7.5 millimeters average depth after construction. As for grooving, it should have 1.0 millimeter or better after three years. Sprinkle treatment should have 1.2 millimeters or more after six years.

After discussing their asphaltic concrete pavement designs, sprinkle specifications and other requirements, we went out on the beltway and looked at some Gussasphalt (which I have slides of). We also looked at several sections of pavement on the way to Waterloo. These pavements contained 45% coarse aggregate with 1/2" to 5/8" size sprinkle rock and 3/8" to 1/2" sprinkle rock.

The motorway A-5 Bypass at Waterloo contained 50% Norway stone with a polish value of 55 and 50% Belgium stone with a polish value of 51. The design in Waterloo was 8% bitumen, 53% sand, 12% filler and 35% coarse aggregate. They used 3/8" to 1/2" sprinkle rock. Forty to fifty penetration grade asphalt was used to

coat the rock, and it was placed at eleven pounds per square yard on 1¼" depth. The contractors were required to provide a minimum of 45 sideway force at 80 kilometers per hour (50 mph).

We then went to Ghent and saw some sprinkle treatment Type 2 which was the 3/8" to 1/2" size. It was placed in 1971 with a 35% coarse aggregate factor. After three years, the side force measurement was 75 at 50 kilometers per hour.

While in Ghent, we visited a contractor and asked specific questions about his thinking on sprinkle treatment. He gave the following comments. First of all, they would not place asphaltic concrete pavement unless the atmospheric temperature was 41° F or higher. They would not place any surface course between Oct. 15 and March 1. Placing sprinkle treatment hot would be very difficult because it would require that the sprinkle rock be transported at from 300° F to 355° F, and it would be impossible to have sprinkle rock at the same temperature at all times. Therefore, it would be necessary to continually change the setting on the sprinkle equipment. He also stated that it would appear that two mix plants would be required to run it hot. His recommendation for precoating sprinkle rock was to precoat at 338° F, 0.8% bitumen with 45 penetration grade asphalt. Jobs that we were to observe were a mixture of 50% porphyry and 50% quartzite. A stockpile should not be more than one meter high, and if it is extremely hot, it should be wetted after 15 minutes. He would not recommend wetting too soon because it might cause stripping of the asphalt from the aggregate. The mixing time is 45 to 60 seconds and the precoated stone should be used within two or three days or covered up so it will not become dusty or contaminated. With sandstone they might use 1% to 1.1% asphalt based on a specific gravity of 2.7. The mix of asphaltic concrete Type 2 with 35% plus 10 material; the maximum size of aggregate is 1/2". Laydown temperature is approximately 290° F, and they utilize a tamping screed laydown machine just as for regular hot mix. The amount of asphalt used in the mix is 8%; whereas, in a normal asphaltic concrete without sprinkle treatment, 6½% is the usual asphalt rate. Special spreaders are used. One type is a Phoenix which rolls on the mat and spreads the aggregate uniformly, and the other type is a Bristow spreader which straddles the mat. The rate of cover-

age is approximately 13 pounds per square yard. They roll it with a 10 to 12 ton (metric) flat wheel roller, and they have an air void requirement on the density of the material so that they have sufficient compaction at 97% lab density.

That afternoon we visited a construction project in progress. This construction was near Lockeren with access to Motorway E-3, and the previously mentioned contractor was placing the material. (Approximately 15 to 20 slides covering the complete operation are available - they are labeled "A" and have the material listed on each slide.)

The following day, Wednesday, June 30, 1976, we went to look at some more sprinkle treatment and also some concrete with both Mr. Decoene, their asphalt man, and Mr. Fuchs, their concrete man. We came upon a joint patching operation on Motorway E-40. They were utilizing 55% coarse aggregate which was 1/4" to 3/8" size. (Slides of this operation are labeled "B") We also came upon a small sprinkle treatment project in the City of Ternat. They were using 55% coarse aggregate and a 2" mat thickness. They were sprinkling 1/8" to 1/4" material with a Vicon agricultural fertilizer spreader. This operation didn't appear to be as effective as some others. (Slides of this operation are labeled "C")

Slides of asphaltic concrete and Portland cement concrete sprinkle treatment within an 80 kilometer radius of Brussels are available. They are labeled "D". Also available are three slides of Gussasphalt, some general slides of various research equipment, and a slide of the director of the organization that I was visiting, Mr. G. Van Heystraeten. Mr. Van Heystraeten gave me several slides which are of general interest as well as slides of the concrete sprinkling machine which was developed by their laboratory.

A copy of the questionnaire which was sent to 49 states and several European countries is contained in the appendix. Also available are numerous reports on the use of sprinkled concrete and bituminous concrete (which is confidential and not for distribution), their specifications, some pictures of the equipment that has been developed for research, and a description of the Belgian Road Research Centre. Additionally, I secured approximately 11 specimens that they ran on their polish machine.

If you have any questions, need additional information, or desire to view the previously mentioned slides, contact the author of this report at the Transportation Planning Division, Research Section.

PART II

Sprinkle Treatment Questionnaire

Interview of

G. Van Heystraeten

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Brussels, Belgium

by

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I. ASPHALTIC CONCRETE

a. Type (hot mix asphalt concrete for use with sprinkle treatment)

Which type do you use?

The most common is type 2. Its depth is thin (1 1/4") and contains 35% of stones (we call stones all that which is retained on the ASTM 10 mesh sieve) and 53% of sand with 12% of filler. This means everything finer than the ASTM 200 mesh sieve is the filler. The bituminous content is about 8 to 8.2%. I will repeat what I said in the first part. The stones with sand and filler equals 100%. This is different than Great Britain; they include bitumen in the 100%. The maximum stone size for this thickness is 3/8". Of course, when the layer is thicker, you have to adapt the maximum size of the stone present in the mix. It is a continuous grading. This is also different than in Great Britain. They have a gap in the grading. Theirs is a more coarse sand and the smaller stone fraction is also eliminated. See what I mean? I found out about this when people spoke about it in Great Britain.

Besides this type 2, we have also studied mixes with 45% and 55% of stones and as you saw on our trials, this is also going very well. The mix of 45% contains about 11% of filler and about 7 to 7.5% of bitumen. The mix of 55% of stones contains 9% of filler and about 6 to 6.2% of bitumen. These types with 45% and 55% of stones are laid at 2", and the maximum size is about 5/8". That is the maximum size of the stones present. These types of 45% and 55% are also continuous grading.

Concerning these three types with 35%, 45% and 55%-- The type with 35% of stones laid at 1 1/4" is very good but the one problem is a good wind, because at that moment, there is a reduction of the temperature and it can be difficult to embed the chippings. In cases of thicknesses of 2", of course, your heat capacity is bigger; in case of that, the wind may not be too bad, the weather can even be cooler.

Of course, when we pass too fast on 2", then the stone skelton has to be higher than the 35% - that is the reason why we use at that moment 35% and 55% of stones, because here in Belgium we have a problem with rutting.

The specifications of the stones we used for the mix is for the mass. They have to be crushed stones. They have to be proper and not too flat, a good flakiness index.

About the sand - in general we use one-half crushed sand and one-half river or natural sand, so the sand fraction is 50/50, of course. There is also a prescription for our sand mix (the proportion, the fraction sand in the asphalt) and this is the recommendation of Mr. Richardson. This is coming from the U.S. so I think you have to know what it is. Mr. Richardson found that there is one grading which is quite interesting for the sand because it gives a good closure of your mix and on the other hand permits still a good workability. I will ask Mr. Decoene to explain it. Also, see it in my article about Hoalat, also the explanation about Mr. Richardson. It is not necessary to haul crushed sand if there is no problem of rutting. The only reason why there is 50% sand in the sand fraction or 33% in our mix is because of rutting. Because if you have no danger of rutting, then you can use natural or river sand, which would certainly be good too.

Where would you not have the danger of rutting? When you do not have much load?

Yes, then you can omit any use.

You mean lower traffic volumes and lighter load traffic?

Yes, when you have no danger of rutting. With maximum load and our densities, the danger we have is with our traffic problems. The reason why I say this is because I suppose in your country, there are places where there is no load. If there is no reason for sprinkle treatment -- but we only do it for reasons.

Let's see, you said 50% crushed and 50% river sand and experiments with 1/3 crushed and 2/3 natural?

In general, there is no one sand that goes into this. We always use 2 or 3 sand in the mix.

You never use 1 sand?

No. You have to mix it to meet specifications. About the filler, we use the same prescription as in the British Standard 812. I have given you an example and a copy of the British Standard.

This filler may be hard to find. Where do you obtain it?

We used to obtain it at Thompson Pit but it was too costly. Now we use, in general, the fines coming from a stone quarry and we have different gradings and fines. These fines are sieved to have just the fraction passing the 200 test. In general, it is limestone filler, sometimes porphyry fines.

Do you find a natural sand?

No, it may have 1%, 2% or 3% of filler, but not enough. Flyash is also used. About the filler to be used - even up to 12% in the case of type 2 with 35% of stones - I would have to say 12% of the real filler. It is a fraction of the filler coming from the sand which always contains some fines. While drying this mixture (the stones and sand) in the plant, you have an aspiration of the total of 12% but the greater part of it would have to be a good filler according to the British Standards.

That is something we do not use.

This is of big importance as you will see in Great Britain next week.

It makes a better mix?

A better mix, a close mix, more dense.

Then you use less asphalt if you use this? If you do not use this, it requires more asphalt to fill it up?

In fact, yes. It is also an absorber of the asphalt and even in the case of mixes of 35% stones and 12% of the filler - even when the asphalt content is a little more - it is not

so dangerous because it is an absorber of the excess but if it has no filler present, then your asphalt must go somewhere and you may have bleeding.

This is the first difference we have; we may have others.

b. Asphalt Cement (percent asphalt, type, penetration, viscosity at 77 degrees F., etc.)

The asphalt is bituminous, about 8.2% for the mix - type 2. The penetration is 40-50 or 50-60. We do not use softer bitumens anymore because of rutting. You can also use 80-100. By type, do you mean bitumen or tar? We use bitumen. You will see in England there is a mixture of bitumen and tar. I spoke about the asphalt content in paragraph I.a. (6% to 8%). But we use 6% only in case of a small stone skelton and 8% in case of a large stone skelton.

Then you have no viscosity?

Yes, we have viscosity, but we do not remember the figures that are in the prescriptions.

Type 2 is a most usable type; the most common type of sprinkle mix. It has 35% stones and is a thickness of 1 1/4". Type 2 is used most frequently on our motorways. Also, we have a type 1 which is 55% of stones. For the moment, this is not a real sprinkle mix; it is only a treatment with a coarse sand. This is not recommended and our experience shows that even this type 1 with a high stone skelton can be chipped with a small size of chipping, as is the case of the type 2 - It is a fact. So the specifications are now in revision at the moment. Even for the type 1, a chipping as for the type 2 will be inserted. Fine chipping will be discontinued.

For the viscosity, we have in fact ring and ball measurement for the bitumens of 40-50 and 50-60.

c. Placement Operation (temperature mix, temperature mat, tack coat, compacted depth)

About the temperature mix - also for this there are specifications and the temperature mix depends

on the penetration, of course, and it is between 145 degrees C. and 180 degrees C. That means 145 degrees C. is 293 degrees F. and 180 degrees C. is 356 degrees F. That is the mix temperature with this hard bitumen. The laying temperature is 140 degrees C. to 160 degrees C. (284 degrees F. to 320 degrees F.)

I do not understand, explain about the temperature mat?

What you are laying the hot mix on. Do you make any measurements?

Oh, the underlayer. No, that is no problem.

We made an error, we put a lot of this down in the wintertime. That is not a good time to put it down.

No! I thought your Texas winters were of a very good temperature?

It is possible for us to put asphaltic concrete down, 3" to 4", in the wintertime, but we call it black base. The deeper the mat, the longer it holds its temperature. You would not put sprinkle mix on that? You should not do any surfaces in the wintertime.

No.

But, sometimes you have to. What do you do in case you want to open up a motorway? Do you make a run on the base course until next Summer?

Sometimes we even let the traffic run on the underlayer for one year to settle the base before we lay the last or the second layer.

Another thing, you ask if there is a tack coat. There is always.

You have to have 100 grams to 250 grams a square meter of residual bitumen so it all depends on your tack coat. It can be 50% water and 50% bitumen but residual bitumen content will have to be between 100 grams to 250 grams per square meter.

Compacted depth, what do you mean?

If you have cold weather, you would not lay it?

The minimum good temperature is 5 degrees C. Our sprinkle treatments ask for good weather. Even when it is hot, and there is a big wind blowing - you may have trouble.

d. Type Laydown Machine - Vibratory or tamping screed?

Our laydown machine is a Barber Green. We have a Blaw-Knox(German). We use vibratory, but we use many types of machines.

II. AGGREGATE

a. Gradation recommended. What about grade 3 for natural skid resistant rock?

Sprinkle aggregate and the gradation recommended - what is important for grading of the chipping is a narrow size. When it is not, then you have segregation in the sprinkle machine because the fines flow out rather than the coarse stones. Also, it is necessary to have another size grading for a good macrotexture because if not, the little stones will fill up the places between the biggest ones. The largest of the 3/4" to 5/8" is not recommended, because it is more difficult to embed it in a mix. You need a bigger quantity, and the bigger quantity you need, the bigger the cost. In addition, the bitumen is more important in coating the bigger stones than the smaller stones.

b. Rates of Application - Square Yards per Cubic Yard (unit weight of aggregate is needed if in pounds per square yard)

I think we spoke about it. In my notes the other day for the 1/4" to 3/8", I showed greater than six pounds. 3/8" to 1/2" greater than eleven pounds/s.y.

Nevertheless, these rates of sprinkling you have on your work depends on the density, and depends on the flaking index. In case the densities of your stones are others than the classic densities I give for this rate 2.6 to 2.8 gm. per cubic centimeter, you have to multiply with a factor to get your rate of spread.

That is based on 2.6?

So if you have a density of 2, then you have to multiply your rates of spreading by 2 divided by 2.7. Lightweight you use less.

c. Placed hot or cold. What about hot aggregate at beginning and end of placement season?

We recommend the chippings or sprinkle always be cold in the sprinkling machine. Why? Because there is a change in the rate of spread when the temperature goes down. This means you have uneven distribution in your work and also there is a danger of cooking together the hot coated chippings. You may having coking or agglomeration.

There is also a danger of the aggregate absorbing the asphalt if you keep it hot too long. I mean if you used it hot and they were all together, the aggregate could absorb the asphalt or the asphalt could dry out. We have had that happen in Texas.

We have had no experience with this.

If you leave it hot too long, it burns up the asphalt. It dries and you do not have enough asphalt. One place in Lubbock they ran it through twice. They ran a batch, let it cool off and there was hardly any asphalt left. They had to run it back through and coat it again.

III. PRECOATING OPERATION (IF USED) SHOULD THE AGGREGATE BE PRE-COATED?

a. Batch Plant

1. Recommend temperature aggregate and asphalt cement

I believe we covered this.

2. Type asphaltic materials, AC

Yes, same as you. AC-20.

Precoating - 145 degrees C. to 160 degrees C. is recommended for the stone. Bitumen temperature just enough for pumping and dispersion in the plant. It is recommended that the stone not be too wet since you might get some stripping. The type is about 40 penetration.

You have never used anything except coating in a hot mix drum? Have you ever used emulsion and a maintainer?

Not for sprinkle treatment.

How about a small job, not enough for a contractor?

We could buy it hot through a plant.

But you would not recommend emulsion even if you got 8/10 of what was on there?

We have had no experience with this.

3. Procedure for storing precoated material

Maximum of three feet. The reason is that you must struggle against oxidation. The temperature must be allowed to drop quickly, within fifteen minutes. Of course you must protect the coated material against dust because the reason you coat it is just to absorb what little dust there is in it.

Do you think you need the asphalt to make it stick in the road?

Yes, when it comes on the mat, then there is an adhesion with the bitumen.

Some people have tried to sprinkle without precoating it.

We have tried also with hot chippings. It works the first two meters but after that the temperature in your truck is dropping so fast that after some time you have cold chippings. In theory it is possible to use noncoated material. In reality you can maintain your chippings on the roadside and if necessary, you can cover your stockpile. If it is on the proper place, it is not necessary to cover it.

How about this three day time limit as long as you keep it covered?

Yes, you can use it even after a month.

Would it be all stuck together?

No, because you sprinkled it. If you sprinkle it before it sticks, there would be no agglomeration. It is not recommended to place your stones for long in the batch plant site because there is always dust around.

But if you haul it somewhere else and cover it?

The problem is they have to be properly stockpiled.

Would it be over three feet high even after cooling?

It is recommended to be as low as three feet just to have a quick drop in temperature.

After you got it cool though?

Then you are right, you can stockpile as you like.

You do not think it would stick together?

No, I do not think so.

4. Other considerations

There are some other things. Coating with about 0.5% to 1% of natural stones and 1% to 1.5% of artificial stones would give a darker coating to the stones. That is a fact.

How would you determine that?

By knowing the absorption capacity by water. We use it sometime, but in general we are so experienced with our stones and the contractor also. They know that one stone needs so much, another stone needs so much, etc.

Eyeball?

Yes.

Also, sometimes we experiment in the laboratory. We take two pounds of stones, we heat it to a temperature of 160 degrees C. and we add to it different weights of coating, for instance .5, .7, .9 and 1.1 and on occasion two pounds. We can see which is the best coating. On both sides, the precoating of the chipping was good.

But is that in your specifications? Minimum and maximum?

Yes, the limits are .5 to 1.5. Too much is not very good, then the danger of cooking together becomes greater. There is no filler added to the bitumen. Before we added some filler to the bitumen, but this is not done anymore.

You are talking about this same filler?

Yes, yes, the fines.

How would you add your filler?

In the moment of the mixing, you add it.

That would be like putting dust back on the stone?

Yes, for a time we thought it was good, but now even the English do not do it anymore. If you add filler to the bitumen before you put it on the stones, the filler makes a barrier between the two. But if you mix your filler before the bitumen, you can do it. But anyway, now we do not.

b. Blade Mix

We would not recommend.

IV. APPLICATION OF SPRINKLE ROCK

a. Type spreader, salt spread, modified tailgate (Grace), self propelled spreader. Discuss English spreader.

About the type of spreader. We did a study about spreaders and we arrived at the conclusion that a Phoenix is the best machine on the European market. This is of English construction. We also used the Bristow. It is made in England, but we think it is not as good as the Phoenix because it has a lower storage capacity. It is important to have a big storage capacity to extend the work period. The Phoenix can hold five tons of stones for a classical width of 3.75 meters wide. The salt spreader is not recommended because it is not so uniform in spreading. You have lots of chippings outside of your lane and you always lose a lot of chippings.

Do you use some kind of smaller grades with a salt spreader?

Yes, in case of 1/8" to 1/4", you can use a salt spreader.

Yes, but there is also an agricultural spreader?

This spreader is good for an original skid but it it not good for the job of skid resistance.

Probably used in the city where you have lower speeds?

Yes.

The Phoenix is a self propelled spreader with rubber tires, and the tires are on the mix. We have done some study about these machines. I made two, Mr. DeCaste made another one, Mr. Decoene another one. I must ask my director if I can send them to you.

I have tried to get some brochures about the spreaders in England. Maybe from the manufacturer in England.

Certainly, they have these things.

We have information also about an American machine named Etnyre. When we look at the documentation, we think this machine is quite similar to the Phoenix. I think it is a machine you have in your country which can be useful for sprinkle treatment. In the States, this machine is used for surface dressings?

Yes, we have several machines used in surface dressings with a gate to control the distribution. I think they could be used; maybe the tires are too small and may leave ruts in the pavement but that could be ironed out.

I think the most important thing for a sprinkling machine is storage capacity, something like five tons. For one day's work, you only load two or three times a day. If you have a storage capacity of two tons, you have to load every 100 meters.

England did have a special truck with a winch and loaded with a little clamshell?

That is one possibility but the best one would unload it from the truck in one operation. Another thing that is important for the sprinkling machine is that there must be no influence from the height of the storage and the quantity of materials in the storage compartment and the other spreader.

If you had outlets located at the high end of your storage compartment, the distribution rate is lower; but if you locate at the low end, you have a bigger rate, so the rate depends on the height of the storage.

The drum and the width - It depends on the pressure the stones give on the drum, and the size and design of the storage bin.

It is important to have a good distribution in two senses, transversal and longitudinal and also that the machine has an easy way to provide chippings during the laydown operation.

b. Time of application after laydown operation. Is it critical?

The moment you spread your chippings is of no importance. What is important is the moment you push in your chippings.

c. Rollers utilized (weight, types and number of passes and sequence)

We recommend steel rollers - ten tons in general. The number of them is two for one lane so that if you have a job of one lane, you would certainly need two steel rollers. If you have a job of two lanes laid down together, then you will need four rollers. Of course, that depends on the width of the roller. We have some rollers 1 meter wide and some 1.50 meters wide - some moving fast, some moving slow. You have to have enough rollers for a good compaction.

The number of passes?

It is the same as for unchipped materials. For compaction, we have no difference than for normal asphalt.

But do you use the steel?

First steel and if you like rubber pneumatic, after it is cool enough. Because if not, the tires can pick up the chippings.

But you do not have special vibratory rollers?

We have some cases. After the material is cool, we put vibratory rollers on it. But when it is too cool, you cannot do a good job anymore - even with vibratory rollers.

The contractor said that he used a flat wheel at first, 10-12 metric tons, and that they required an air voids of 2.4. They might get about 97% density.

d. Measurements of sprinkle rock application. What about a simple test to determine?

You mean to check out the rate of spread? We have a plate about three feet square. Not too small and not too big because it is heavy. The plate is then weighed on a scale to determine the spread.

Virginia has a little canvas thing and they just lay it down, roll over it,then pick it up and weigh it.

So we think every individual measurement you take must lay within a range of your fixed rate of spread plus or minus two pounds. If you are fixed at nine pounds - from seven to eleven pounds - every individual measurement would have to be in that range. To investigate the reliability of your spreader, you can make an inspection of the machine and test run before laying operations.

Do you need a trial run to see?

No. Because the contractor knows his machine. When he buys it, he can do some measurements and adapt the machine.

How do they know how far to open the opening?

That you have to know before the work starts.

But the engineers do not do that?

No, if you start and you make a mess, then you change the number of passes (see paragraph IV.c.). The contractor just keeps going until the proper density is reached. They never stop the rollers on the side.

You have to have enough rollers to get the proper compaction?

Yes.

But you do not run in-place density tests; you have to do it backwards by cores?

We tried it in some experiments but now a machine is operational and it can be bought. We do not have it at the moment.

We have some areas where we do lay it by density requirements. We think that is the way to go.

The English might do that also.

One thing that is interesting is that speed of sprinkling is adapted to the asphalt laydown machine. In the beginning, I remember the Phoenix. The speed was too high and it would stop every time. That was no good. Now they have adapted the machine similar to the finishing machine.

e. Time of opening of finished roadway to traffic?

In general we open traffic the evening of that day when the asphalt has the temperature of the air temperature. It is not recommended to open it sooner. Yesterday we saw a little job stopped to traffic. They laid the asphalt about 10:00 and they waited until 2:00 to compact it. It is recommended that you brush your road before opening to traffic. Recommend brushing and if possible vacuuming. Because it is not enough to evacuate your chippings from the side of the road.

We do not use a vacuum. Do you have special vacuums?

Yes, you can buy here in Belgium or England.

f. Other considerations

In case there is an interruption of your asphalt laying on the last 10-20 meters and your sprinkling machine is on, at that moment you must activate your machine to start the rollers to compact the surface. If you wait a few hours, it will be too late and you will have a bad place in the roadway.

Road temperatures - I think we spoke about 230 degrees F. to 270 degrees F. But just in case of cold temperatures or high wind, it may not be enough. It may be necessary to pass these limits. If you roll too hot, there is a bleeding. What we try sometimes is to make one pass, then put the chippings in at a temperature above 270 degrees F., and wait for the mass to cool down to between 230 degrees F. and 270 degrees F.

You mean make a pass with a roller?

One pass to be sure that the stones are on it. In case of wind, your upper layer may be too cool at that moment and you cannot push in the stones.

So what you do is if the temperature is too hot and it is windy? You go ahead and sprinkle and make one pass with the roller and wait?

Yes. Also, we are very severe about the air void content because we desire a very impermeable surface. Our void content is about 3% mean which equates to about 5 or 6 for all places.

How about the filler as far as permeability?

You have to compact it very good.

You have to have some density?

Yes.

V. MAINTENANCE

I have spent the last three days looking at test sites and how well they performed. Can you give me a tabulation of your experience since you first started placing sprinkle treatment?

1962 - We tried it for the first time on a road in Antwerp, Belgium. And this road is doing very well. It is the most trafficked road in Belgium. It was a good road to begin with. The sprinkling was done with a mix of porphyry and synopal.

Same procedure?

Yes, at the time we did not have good machines. But even now it is a very good road. None of us saw the operation. I think it was put down by a Bristow machine.

VI. TESTING

a. Percent residual asphalt on precoat aggregate (if used)?

Do you test for residual asphalt on precoated aggregate?

You can get this by before and after tests.

Do you do that?

Yes, We control the use in the solvent and then you weigh it again after that. It is also interesting to see if your bitumen is oxidized because in case of oxidized bitumen, not everything is coated. There are still particles on the stones and that indicates that the rocks are oxidized.

So if your range is one, you run that test to see if it meets that range on the job?

Yes.

b. Skid Resistant History

Do you do that? Do you keep up with all of your various rocks, aggregate sources or do you depend on the polish value?

Certainly for all our rocks and even for the other ones. We keep both.

You have to keep up with them for three years for the contractor but he said you do not normally do it after that?

We follow our test sections as well as possible with measurements three or four times a year to see the seasonal influences, etc. I can say that with our sprinkle treatment specifications, the contractor has fewer problems which for roads with normal asphalt concrete, it is difficult to inspect our prescriptions. That is the best answer I can give. Sprinkle treatment is a good thing for our skid resistance, I think it is.

Nationwide, countrywide, the Road Ministry does not keep a history of skid resistance?

No, not after the three year guarantee period. But now there are some ideas to buy equipment and to investigate all our roadway networks.

Who has equipment now, just you?

We have one skid trailer and Administration has three trailers. Administration, that is the Road Ministry.

You mean it is different than yours?

Yes, a little different but in fact it is also satisfactory. We both measure sideways force. They are different but the result is quite similar.

Do you have a factor between yours and theirs or is it the same?

It is quite the same.

But they only use theirs to keep up with the contractor?

Of course, they have to follow every job. That is the reason they have three.

But you have not kept histories of the roads? You have not made a nationwide survey?

No.

We go all over the State of Texas and keep the history year after year and get performance of various aggregates to tell how they perform. It does not tell you about construction, only what is in there.

c. Minimum mat temperature at same time of sprinkle rock application

I think we have spoken about that.

Do you have a test for mat temperatures?

Before laying, outside temperature should be about 5 degrees C. There must not be water stagnation on the underlayer. Then we can work. The mat is the underlayer.

This is what you are laying. You take a little thermometer and you put it down and take a reading?

To judge the temperature of the mix? Yes, we use a thermometer. On all sections when we do a job we are alwlays there with the thermometers. There are our specifications in our prescriptions but they are not what engineers call requirements. Your technique is to measure the temperature continuously by infrared. Mr. Gorshe will speak about it this afternoon.

VII. ECONOMICS

a. Comparative costs of sprinkle application with that of high quality aggregate in hot mix asphalt concrete and high quality skid resistant aggregate blends in hot mix asphalt concrete.

This is no problem. Sprinkle application will be cheaper.

Now I talked to you about that and as I understand what we looked at yesterday evening, 1973 was the first time you used an aggregate with a low polish value, different than the sprinkle rock. Is that true?

Yes.

So by using your local material you get a cheaper asphaltic concrete rather than importing sprinkle from Norway or somewhere else?

Yes, it is certainly more economical with our limestone quarry. The question here is to compare the cost of an asphalt sprinkle treatment quarry stone with that of high quality aggregate stones. Certainly it is cheaper in the case of sprinkling.

b. Is there a minimum size project below which sprinkle treatment would not be practical nor economical?

Is there a job too small where you do not need sprinkle treatment? In case the job is very small, what do you do? Would you not use sprinkle treatment there?

And why not?

So no job would be too small?

No.

VIII. UNSUCCESSFUL PROCEDURES (DESCRIPTION OF ACTIVITIES WHICH ARE CONSIDERED UNSATISFACTORY)

a. Excessive penetration of aggregate into the mat

It is uncommon to have them completely penetrate into the mat. We saw the mortar around the stones worn off by traffic in very little time so even when the stones completely penetrate the mat, they will come up a little because the mastic wears away around the stones.

I am talking about asphalt.

Yes, even asphalt, when the mix is too rich in bitumen, you will have bleeding and the chips will sink in completely and the design must be good to prevent this.

Is that just a problem of your hot mix design or your asphalt concrete design?

With a mix of 35% and 12% filler, the bitumen content is not so critical. If you put 8, 8.1, 8.2, 8.3, you will not have bleeding because just your filler takes up the excess of bitumen.

Anyway, it really depends on the asphaltic concrete design and you say the mortar wears out faster than the rocks?

Yes, in fact above 300 degrees F. there is a danger that chippings in the mortar will not have a very high skid resistance at the beginning but after awhile it will improve as the mortar wears away.

b. Too much precoat on aggregate

Too much precoat can be a problem in the beginning because you get a lower skid resistance. This precoat eventually will be worn away by traffic, the stones will come up and there will be no problem.

c. Too little or too much aggregate per square yard?

Too little will give you no macrotexture and too much you have the danger of embedding the chippings.

Questions from Lee Dong, FHWA

I. GENERAL INFORMATION AND ENVIRONMENTAL CONDITIONS WHERE SPRINKLE MIX IS USED.

1. Usual traffic on roadway where used, particularly truck traffic? ADT? Percent or number of trucks?

I can only say about type 2 of our sprinkle treatment, it is used on all types of roads from 30,000 vehicles a day to roads with only 3,000 vehicles a day. It is no trouble to use the sprinkle treatment for all kinds of roads - heavy traffic or not.

2. Types of speed of vehicles on roadway? High, medium or low?

The same for the speed. You saw the motorway. We have a speed limit of 80 mph. Other roads have less speed. There is no difference in the techniques of sprinkling, for that type of road or that type of speed. The only thing different is the polish value of chippings have to be adapted to traffic.

3. Freeze-thaw conditions? Is sprinkle mix affected by, and in what way?

My answer is no, there is no problem.

4. Are chains and/or studded tires used where ice and snow? If so, how well does the sprinkle mix perform?

These days we do not have a lot of studded tires, so we have no experience with it but I can say that in certain countries having studded tires, they show that sprinkling gives a better resistance to the tires. See Sweden. Anyway,

studded tires are forbidden here.

II. AGGREGATE: WHAT ARE THE STRIPPING CHARACTERISTICS OF THE AGGREGATES USED FOR SPRINKLE MIX? IS A STRIPPING TEST EMPLOYED AS AN AGGREGATE SPECIFICATION REQUIREMENT? ARE ANTI-STRIP AGENTS USED AS AN ADDITIVE TO THE ASPHALT?

Probably some cases,but I do not know of any. In general there are no additives on the asphalt. The stripping tests, we did not have for our chippings because we know our stones. We are a little country, we know every stone quarry, but we have some experience with others from abroad. There will be no problem of adhesion or stripping.

III. COVER SPRINKLING OF PORTLAND CEMENT CONCRETE WHERE EXPERIENCE HAS BEEN GAINED.

Explanation of our practice - We think that with our sprinkling executions on motorways of continuously reinforced concrete, the road is good for 40 or 50 years. We hope so, but then we think that at some moment the coarse aggregate must come up to the surface. If we have to groove the concrete, it is very expensive because we use a diamond saw. Chipped concrete is more durable than grooving.

You make your concrete out of silicious river gravel?

River gravel and limestone or porphyry.

You have silicious gravel and limestone for a minimum polish value?

No, it is only limestone.

You use a lot of limestone in your concrete?

Yes.

What about natural stones?

All types, yes, all pavements and main roads.

The only case we studied concerned the sprinkle treatment of light stones in the country. It proved interesting and economical. A minimum polishing value of 50 was used but we can hope to make a study of three types of coats with a polish value of 50, 60 and 70 to see the behavior of the stones with traffic later in

future paving. We will use a polish value of 80.

I can agree with you in the beginning indeed the stones of the concrete do not appear at the surface because more of it is covered. We are speaking now about grooved concrete. The speed at which this aggregate appears certainly depends on the amount of cement in the mass and the perfection of the curing compound. In part the problem is it must come to the surface and even then it will be polished with time. I think the only solution is the chippings.

The biggest problem with our concrete is it does not have enough texture so now we tried transverse grooving with a polish value of 50-55 for the C.A.

I am trying to figure out if in the U.S. sprinkling concrete would be advantageous?

The operation of sprinkling always costs more than the operation of grooving. That is a fact. But you have to see what you have to mix in the concrete.

I cannot understand why you have no problem with concrete but you have a problem with asphaltic concrete. I do not see a big difference between these two types.

PART III

BELGIUM'S ANALYSIS OF TEXAS' SPRINKLE TREATMENT TECHNIQUE

From what I can see on the slides and pictures, I think your thickness is one thing. Second, the minimum is 1 1/4" (3 cm), the precoating I think you will be safer to do it with bitumen. Your spreading technique - I think you have to use a machine as you saw - Phoenix or Etnyre, not salt spreaders or anything like that. Of course, you have to do it in good weather. As you said, it was sometimes bad weather. You have to limit your stone content in the mass at 55. That is the absolute maximum but we recommend you try a mix with 35% or 45% of stones above the 10 mesh.

It is more secure to have a good embedding of the chippings. I hope that with what you saw these days and what you saw at the construction site, it will give you some good ideas. You are in a better position than I am to compare your execution with ours, because you saw them both.

In our efforts we have tried to leave the aggregate sticking up. We thought it would give texture, etc. Yours is flush and you do not lose the aggregate?

We are sure that afterwards the wear of the mortar will expose the stones a little and then there is no danger of losing them.

Why does the aggregate come up when you sprinkle the top layer? The mortar is wearing more than the stone.

It appears that you may have a problem with rutting but it has nothing to do with sprinkle treatment. We have a rutting problem with our classic concrete because we have a very heavy axle load. In general, it is not even the surface layer that is responsible for rutting.

You think that is because there are too many fines?

There are a lot of things which are responsible for that. At our specifications, let us say that they only get a minimum of bitumen but in the upper limits so it somestimes makes the contractor put in more asphalt than is required. Then you are sure to have a low void content. All these things are important.

We have prescriptions for a minimum of asphalt for every core, a maximum for every core, a minimum of stone content, a minimum of filler content for every core that is taken. To be paid 100%, the contractors must comply. But now our new prescriptions will also impose a maximum bitumen content, a maximum filler content; this was one reason for rutting.

I think our surface may get 130 degrees F. or 140 degrees F. Your temperature may never get that hot. Did your coarse aggregate factor 35 stand up to that?

135 degrees F. on the surface? What do you mean? That is 54 degrees C. There are days we have high temperatures also.

APPENDIX

A PARTIAL LIST OF SUBJECTS CONCERNING SPRINKLE TREATMENTS

Discussion should describe procedures actually utilized as well as recommendations based upon your experience.

I. Asphaltic Concrete

   a. type (hot mix asphalt concrete for use with sprinkle treatment)

   b. asphalt cement (percent asphalt, type, penetration, viscosity @ 77°F, etc.)

   c. placement operation (temperature mix, temperature mat, tack coat, compacted depth)

   d. type laydown machine - vibratory or tamping screed

   e. other considerations such as ambient temperature and ground temperature

II. Aggregate (Sprinkle)

   a. gradation recommended. What about grade 3 for natural skid resistant rock?

   b. rates of application - square yards per cubic yard (unit weight of aggregate is needed if in pounds per square yard)

   c. placed hot or cold. What about hot aggregate at beginning and end of placement season?

   d. polish value. Should a polish value be required? If so, what range, etc.?

   e. type (lightweight, etc.)

   f. other considerations

III. Precoating Operation (If Used) Should aggregate be pre-coated?

   a. batch plant

      1. recommend temperature aggregate and asphalt cement

      2. type asphaltic materials, AC

      3. procedure for storing precoated material

      4. other considerations

b. blade mix

1. type asphaltic materials recommended

2. moisture content of aggregate

3. procedure of application of asphaltic materials

4. stockpiling precoated material (depth, protection, (Should it be covered) manipulations), etc.

5. other considerations

IV. Application of Sprinkle Rock

a. type spreader, salt spread, modified tailgate (Grace), self propelled spreader. Discuss English spreader

b. time of application after laydown operation. Is it critical?

c. rollers utilized (weight, types and number of passes and sequence)

d. measurements of sprinkle rock application. What about a simple test to determine?

e. time of opening of finished roadway to traffic

f. other considerations

V. Maintenance

a. tabulation of projects in chronological order (location, date, description, skid history compared to control)

b. estimated pavement life

c. procedure for repair to deficient areas

e. other considerations. Methods of deterioration and unusual maintenance problems.

VI. Testing

a. percent residual asphalt on precoat aggregate (if used)

b. skid resistant history

c. minimum mat temperature at time of sprinkle rock application

d. other considerations

VII. Economics

a. Comparative costs of sprinkle application with that of high quality aggregate in hot mix asphalt concrete and high quality skid resistant aggregate blends in hot mix asphalt concrete.

b. Is there a minimum size project below which sprinkle treatment would not be practical nor economical?

c. other considerations

VIII. Unsuccessful procedures (description of activities which are considered unsatisfactory)

a. excessive penetration of aggregate into the mat

b. too much precoat on aggregate

c. too little or too much aggregate per square yard

d. opening mat to traffic too soon

e. precoating aggregate without dispersing agent causing aggregate to be only partially coated or speckled with asphalt cement

f. gradation not compatible with hot mix type

g. weather (temperature, rain, himidity, wind)

h. other considerations

Data to be Included in Questionnaire
Requested by Mr. Lee Dong, FHWA

I. General information and environmental conditions where sprinkle mix is used.

(1) Usual traffic on roadway where used, particularly truck traffic? ADT? Percent or number of trucks?

(2) Types of speed of vehicles on roadway? High, medium or low?

(3) Freeze-thaw conditions? Is sprinkle mix affected by, and in what way?

(4) Are chains and/or studded tires used where ice and snow? If so, how well does the sprinkle mix perform?

II. Aggregate: What are the stripping characteristics of the aggregates used for sprinkle mix? Is a stripping test employed as an aggregate specification requirement? Are anti-strip agents used as an additive to the asphalt?

III. Cover sprinkling of Portland Cement Concrete where experience has been gained.

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