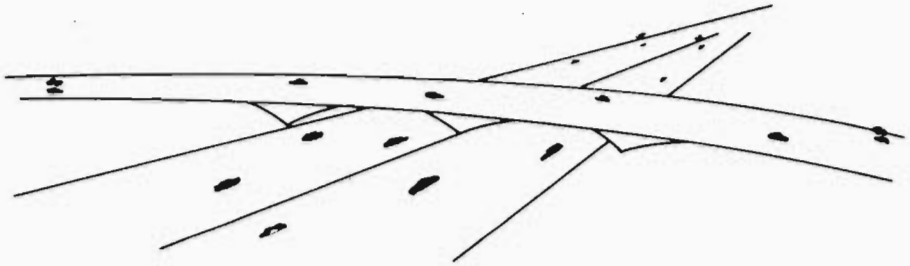

# DEPARTMENTAL RESEARCH

Report Number SS 20.1

## SPRINKLE TREATMENT OF ASPHALTIC CONCRETE IN ENGLAND OR "CHIPPING ASPHALT"

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

# SPRINKLE TREATMENT OF ASPHALTIC CONCRETE IN ENGLAND OR "CHIPPING ASPHALT"

by

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Texas State Department of Highways and Public Transportation


Special Study Report Number 20.1

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SUMMARY

This is an outline of a trip to England by John F. Nixon, Engineer of Research, Texas State Department of Highways and Public Transportation, on July 5-8, 1976, concerning their use of sprinkle treatment, its degree of application, benefits and overall performance.

Discussions with England's representatives have indicated that sprinkle treatment provides for better textured surfaces, a surface that is easier to roll, easier to work with, a surface that is more impervious to water, has better sideways force measurements with resultant greater reliability of roadway pavement at minimum cost.

CONCLUSION

Climatically, England is more nearly like the northeastern section of the United States. Compared to Texas, it is much colder, wetter and not subject to temperature extremes.

During my visit, I inspected several of their roads and was surprised to find very little weather damage to road surfaces. Considering the high population count and traffic density along with their weather conditions, I can only conclude that the construction and maintenance techniques of England provide exceptional reliability of their road system.

## RECOMMENDATIONS

It is recommended that the procedures outlined in this report concerning methods for mixing, laydown, stockpiling, applications, equipment changes and testing be tried at a control test site to insure the validity and accuracy of the information obtained from England. Once the information has been verified, it is recommended the results be formulated into an implementation report and distributed for compliance.

PART I

Monday morning, after introductions, I was briefed on the Transport and Road Research Laboratory's organization. Afterwards, we toured the laboratory where my host explained asphaltic concrete pavement design techniques. The maximum allowable weight limit for their pavement is 32 tons and 9 tons on the axles. Their major design uses a mix of 30% coarse aggregate, 60% fine aggregate and 8% filler. Generally, the filler is crushed limestone and 8% asphalt. Recently they discovered that a mix made up of 20% coal tar (Trinidad Lake asphalt) mixed with their local asphalt was very susceptible to temperature variations. So now they use bitumen. So far they see no bad effects from the exclusive use of bitumen; however, in order to determine which of the asphalts works best, in so far as erosion or wear of mortar leaving the aggregate exposed, a method of measure was developed called dielectric constant or permittivity.

That afternoon we visited the Wycombe experiment and looked at various types of sprinkle treatment, rates, etc. All of them looked very good.

In England they have a polish rating for their stones. Appendix A outlines the minimum polish values for chippings or coarse aggregate.

Tuesday I visited with Eric Green, a chemist. We discussed his observations concerning his experiments. Some of his observations are as follows:

1. In the treatment of sprinkle rock, Mr. Green indicated that stockpiles should not be higher than one meter (39"). In the experiment, a mix heated to 310 degress F. (154 degrees C.) stacked a little over one meter high, had a temperature rise of an additional 56 degrees. The increased temperature caused the asphalt to coke and some coating to be vaporized.
2. For sprinkle treatment, it appears that gap graded material is superior to continuous graded material.
3. He further indicated that blown asphalt can be used to eliminate some of the asphaltenes.

Thursday, Mr. Jacobs of the TRRL and I inspected a chipping operation. I noted they used large stones in the operation and from an appearance point of view, it looked excellent. We took slides of this chipping operation and they are available from the following source:

Mr. Phillip L. Wilson,
State Planning Engineer
Transportation Planning Division
File D-10R
State Department of Highways
and Public Transportation
P. O. Box 5051
Austin, Texas 78763

After the inspection, we returned to Mr. Jacob's department where we reviewed the film and slides I had brought from Texas. My purpose was to seek their advice on our equipment use and our test procedures based on the films. They provided the following suggestions:

1. We were not getting enough coating and the coating of chipped rock was not uniform.
2. The asphaltic mix was too stony.
3. The production method appeared poor.
4. Our salt spreader was not efficient. They suggested a Bristow.
5. Keep the chipped rock from sticking together by using the correct amount of binder. We could even consider use of filler to keep the rock from sticking together.
6. Use the petrol wash test or the hot sand test to determine if you have enough coating on the stone.

   The first procedure is to wash the stone with petrol and if all the asphalt comes off, it is good; and if not, it is bad.

   The second procedure may be used where asphalt coking has occurred. This procedure is to drown the rock in heated sand. If the sand coats the rock, the asphalt content is sufficient; if not, the asphalt content is not sufficient.
7. The mix has too much stone or plus 10 material.
8. The gradation of chippings appears to be too wide.
9. Lay only when the outside temperature is 0 degrees C. (32 degrees F.) and rising and then only in thick lifts.
10. Stockpile the coated chippings (sprinkle rock) a maximum of two feet high and water the stack if necessary to cool it off. Watering could be eliminated if temperature of the stockpile does not rise above 300 degrees F. (150 degrees C.)

About the pavement in England - very few cracks were noted. Maximum P.I. of English soil is approximately 70. Normally the moisture content does not change over 1% annually in the soil and freezing over 2" is very rare.

Slides of asphaltic concrete treatment with chippings or sprinkle rock are also available from D-10 Research.

The sprinkle rock used in England appears to be larger in size and more macrotextured. Sprinkle treatment is used in nearly every situation; city streets, motorways, local roads, etc. English roads do not have the problem of rocks displacing from the mortar and breaking windshields.

For your guidance, our questionnaire and England's answer are outlined in Part II of this report. A blank questionnaire has also been included in this report (see Appendix C).

PART II

I. ASPHALTIC CONCRETE

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

*Type of hot mix used is hot rolled asphalt, conforming to the British Standard 594 of 1973. The Marshall procedure is used for designing the mix. The 30% coarse aggregate which is used in the mix is that which is retained on the #8 sieve while the fine aggregate consists of 50% field sand and 50% crushed sand.*

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

*The asphalt content is about 7.9% of the mix and this percentage is not critical. The type of penetration is 40 to 50; however, England has no viscosity requirements.*

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

*The temperature of the mix should not be more than 374 degrees F. (190 degrees C.). The temperature of the mat is normally 212 degrees F. (100 degrees C.) to 266 degrees F. (130 degrees C.). The English use a tack coat at the rate of .02 to .05 gallon per square yard but do not use a tack coat on new surfaces.*

d. Type laydown machine - vibratory or tamping screed

*England uses both vibratory and tamping. For equipment they use a Blaw-Knox (German) and Barber Green (American).*

II. AGGREGATE (SPRINKLE)

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

*Gradation recommendations are covered in British Standard 594 with references to British Standard 63. The gradings are as follows:*

Chippings
Percent by Weight Passing

| | 3/4" size | 1/2" size |
|---|---|---|
| 1" | 100 | |
| 3/4" | 90-100 | 100 |
| 1/2" | 0-25 | 90-100 |
| 3/8" | 0-4 | 0-30 |
| 1/4" | | 0-4 |
| #200 | 0-2 | 0-2 |

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

*The rates of application are approximately one cubic yard to 250 square yards with a sprinkle rock density of 2.6 to 2.7. Cover 2/3 of surface with chips.*

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

*They have used only cold placement with sprinkle rock. They have never placed it hot.*

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

*The polish value is generally 55 for easy sites and 59 for most roads. In dangerous spots it is 62 to 63.*

e. Type (lightweight, etc.)

*Type material used is calcined bauxite.*

f. Other considerations

*For the sprinkle treatment:*
*1) The stockpile should be limited in height to one meter (39")*
*2) Stockpile should be watered down within* 15 *minutes*

*3) A coking test run*
*4) Run a test on sprinkle rock for adequate coating*
*5) Insure that sprinkle rock has good abrasion values*

III. PRECOATING OPERATION (IF USED) SHOULD AGGREGATE BE PRECOATED?

a. Batch plant

1. Recommend temperature aggregate and asphalt cement

*The English require a flakiness test according to prescribed standards. In the batch plant, the temperature for coating is between 266 degrees F. (130 degrees C.) to 363 degrees F. (184 degrees C.) and for your asphalt cement a maximum of 347 degrees F. (175 degrees C.). The mixture is discharged at 266 degrees F. (130 degrees C.) to 363 degrees F. (184 degrees C.). The English would not recommend cold precoating of the aggregate; however, they do believe precoating should be done.*

2. Type asphaltic materials, AC

*Type material used is Pen 50 bitumen from the Middle East.*

3. Procedure for storing precoated material

*Stockpiles should be no higher than one meter (39"). The temperature should be maintained below 300 degrees F. (150 degrees C.) and if necessary, should be watered down.*

4. Other considerations

*1) Perform a coking test*
*2) Perform the hot sand test*

b. Blade Mix

*They have not done any precoating with blade.*

IV. APPLICATION OF SPRINKLE ROCK

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

*The English use the Phoenix or Bristow with a straddle up to 18 foot wide. They do not use a salt spreader. They think the Etnyre (U.S.) would be an acceptable spreader.*

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

*Immediately after paver.*

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

*The English use three to ten ton flat 3-wheel going backwards. The two wheels are larger than the one single wheel. The roller makes eight to ten passes and thoroughly compacts the surface. Although it has 8% to 10% voids in the mix, after compacting it is impervious.*

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

*They measure sprinkle rock application on an aluminum pan (See Appendix B - British Standard 594, C.1). Normally the English try to achieve a 75% coverage of their aluminum tray surface.*

e. Time of opening of finished roadway to traffic

*When pavement temperature reaches air temperature.*

V. MAINTENANCE

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

*According to their reports, they have had no maintenance.*

b. Estimated pavement life

*Normal pavement life is ten to fifteen years. The Wycombe experiment is nine years old and the Bladebush design is fifteen years old.*

c. Procedure for repair to deficient areas

*The English use infrared heat to heat and roll their material taking into account the thickness and size of stones.*

d. Other considerations

*Chippings should not be sprinkled when the weather is too hot, because if coking of the aggregate occurs, the stones may work loose. Generally, this is noticeable on the first day.*

VI. TESTING

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

*The English recommend 1.5% plus or minus .3% and suggest a higher percentage if the rock is more porous.*

b. Skid resistant history

*They maintain a skid resistance history and concentrate on their experimental jobs.*

c. Minimum mat temperature at time of sprinkle rock application

*100 degrees C. (212 degrees F.)*

d. Other considerations

*Rolling temperatures - if it is too hot the English still make one pass with a roller to place the rock within the mat, then they may hold up for awhile.*

## 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

*England's estimate of sprinkle treatment cost is about 20¢ per square yard. They indicate it is cheaper than using high quality aggregate in the mix. Sprinkle treatment provides better micro-texture and macrotexture.*

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

*There is no minimum size project on which they would not use sprinkle treatment.*

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

a. Excessive penetration of aggregate into the mat

*Excessive penetration was caused primarily by the mat being too hot; however, through experience they have eliminated excessive penetration problems.*

b. Too much precoat on aggregate

*Their experience has shown that too much precoat on aggregate causes lumps in the stockpile.*

c. Too little or too much aggregate per square yard

*Not enough aggregate per square yard will cause softening of the pavement, poor road surfaces and resultant short life of the roadway. Too much aggregate is wasteful, will also cause a poor road surface and the loose stones will create road hazards.*

d. Opening mat to traffic too soon

*England has not had it happen.*

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

*They do not precoat aggregate with agent.*

f. Gradation not compatible with hot mix type

*No problems.*

g. Weather (temperature, rain, humidity, wind)

*Low temperature will cause lumping of the aggregate. They have not experienced any problem to speak of with rain and humidity; however, wind is their biggest problem because it cools the skin, crusting it over, and keeps the chipping machine and roller from doing a satisfactory job. The corrective measure is to keep the roller close to the laydown machine. Chippings which are normally run by the contractor in the evening should be left to cool overnight and then used the next day.*

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?

*There is no limitation as to where sprinkle mix is used.*

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

*All speeds under all conditions.*

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

*They have no problems.*

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

*Chains are not permitted so they have no problem.*

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?

*They do not use any stripping test for sprinkle mix. No problem.*

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

*They have no experience with PCC sprinkling.*

# APPENDIX A

## MINIMUM POLISH VALUE

| | Chippings or Coarse Aggregate when Chippings Not Used | Coarse Aggregate for Rolled Asphalt & Dense Tar Surfacing when Chippings are Used |
|---|---|---|
| A. "Difficult Sites" e.g. | | |
| 1. Roundabouts & their approaches<br>2. Bends of less than 500 ft. radius on unrestricted roads<br>3. Gradients 1:20 or steeper and longer than 100 yards<br>4. Approaches to traffic signals on unrestricted roads | 62 | 45 |
| B. "Average Sites" | | |
| 1. Motorways<br>2. All other roads including those in urban areas which carry more than 2,000 vehicles per day | 59 | 45 |
| C. "Easy Sites" | | |
| Roads not included in "A" or "B" but carrying more than 1,000 vehicles per day | 45 | No requirements |

Other Requirements

| | |
|---|---|
| Up to 1,750 commercial vehicles per day per lane | Maximum aggregate abrasion value - 12 |
| More than 1,750 commercial vehicles per day per lane | " " " " - 10 |

# APPENDIX B

## 1.6 Mixing

The coarse and fine aggregates shall be thoroughly dried and shall be fed at a temperature of 150 °C to 205 °C (but not exceeding 185 °C in the case of asphalt made with pitch-bitumen binder) into a mechanical mixer of approved type. The filler and asphaltic cement shall be added, the latter at a temperature not exceeding 175 °C, (160 °C for pitch-bitumen binders). At no time shall pitch-bitumen be stored in bulk at temperatures in excess of 160 °C. Mixing shall continue until the aggregate has been uniformly mixed and coated with asphaltic cement and on discharge from the mixer the temperature shall not exceed 190 °C or 170 °C for mixtures made with pitch-bitumen binder.

NOTE. See also **D.2.1.**

## 1.7 Chippings for application to surface of wearing course

**1.7.1 General.** The chippings to be rolled into the surface of rolled asphalt wearing courses and their manner of coating shall comply with the requirements given below. (For the application of the chippings see **4.2.9.**)

**1.7.2 Chippings.** The chippings shall comply with the requirements of BS 63, shall be of either 20 mm or 14 mm nominal size and shall have a size and shape index of 60 or less.

NOTE. Size and shape index = Percentage of undersize* + Flakiness index†

When intended for use on motorways, trunk and principal roads carrying high speed traffic, and on hazard sites, the chippings shall also comply with the following requirements.

(1) Not less than 80 % by mass shall be of the specified size.

(2) The Flakiness index shall be less than 25.

**1.7.3 Coating.** The binder used for coating the chippings prior to application shall conform to the requirements of columns 1, 2 or 3 of Table 1. The chippings shall be completely coated with the specified binder at a rate found on analysis of 1.5 ± 0.3 % by mass. The analysis shall be carried out on chippings taken from the stockpile when their temperature is below 130 °C.

The chippings shall be dried and fed into the mixer at a temperature of 130 °C to 185 °C. The binder shall be added at a temperature not exceeding 175 °C and the coated chippings on discharge from the mixer shall be in the range 130 °C to 185 °C.

In order to minimize the formation of insoluble material in the binder the coated chippings shall, on discharge from the mixer, be cooled quickly to ambient temperature by the application of clean water or by spreading out in a layer not exceeding 1.0 m in thickness. Chippings shall be cooled to and maintained below 160 °C.

## 1.8 Transportation

The hot asphalt shall be transported to the site in suitably insulated lorries e.g. those having metal-lined wooden bodies and properly sheeted so as to prevent an excessive drop in temperature and as a protection against adverse weather conditions. For mechanical laying, the delivery of the material shall be co-ordinated with the rate of progress of the spreading machine in order to avoid, as far as possible, interruption of spreading. To facilitate discharge of the asphalt, dusting of the floor of the vehicle is permissible, but the amount of dust used shall be kept to the minimum necessary. Diesel oil shall not be used for this purpose.

The asphalt shall be delivered to the site of work at the following temperatures.

(1) Mixtures made with bitumen or lake asphalt-bitumen: 125 °C to 190 °C.

(2) Mixtures made with pitch-bitumen: 120 °C to 170 °C.

NOTE. Recommendations for the measurement of asphalt temperatures are given in Appendix E.

* Percentage of undersize is the percentage less than the nominal size as specified in BS 63.

† Flakiness index as determined in accordance with BS 63.

**4.2.9 Application of chippings.** In the case of wearing course mixtures containing 40 % or less of coarse aggregate, a roughened surface shall be obtained by the application of coated chippings complying with the requirements of 1.7. If a roughened surface is not required the coated chippings shall be omitted, subject to the agreement of the purchaser or his representative.

Where a roughened surface is required the asphalt surface shall, after initial compaction (e.g. by the laying machine) be covered with a uniformly distributed layer of coated chippings at the appropriate rate of spread, and rolled at a temperature above the minimum specified in **4.2.10.**

On motorways, trunk and principal roads carrying high speed traffic and on hazard sites, the rate of spread shall be the maximum practical rate consistent with permanent retention of the chippings in the asphalt. Table 16 gives a guide to the rate of spread in such cases. See also Appendix C.

**Table 16. Rates of spread of coated chippings for motorways, trunk and principal roads and hazard sites (adjusted for properties of chippings)**

| Size and shape index (see Note 2) | Rate of spread* | | | | | |
|---|---|---|---|---|---|---|
| | 20 mm nominal size chippings | | | 14 mm nominal size chippings | | |
| | Relative density† | | | Relative density† | | |
| | 2.6 | 2.7 | 2.8 | 2.6 | 2.7 | 2.8 |
| | kg/m² | kg/m² | kg/m² | kg/m² | kg/m² | kg/m² |
| 20 | 11.0 ± 1 | 11.5 ± 1 | 12.0 ± 1 | 8.5 ± 1 | 9.0 ± 1 | 9.5 ± 1 |
| 40 | 10.5 ± 1 | 11.0 ± 1 | 11.5 ± 1 | 8.0 ± 1 | 8.5 ± 1 | 9.0 ± 1 |
| 55 | 9.5 ± 1 | 10.0 ± 1 | 10.5 ± 1 | 7.5 ± 1 | 8.0 ± 1 | 8.5 ± 1 |

* Rates of spread of coated chippings for other sites: the rate of spread of chippings for roads other than motorways, trunk and principal roads carrying high speed traffic, and for hazard sites may be reduced by 1.5 kg/m² for 20 mm chippings and 1.0 kg/m² for 14 mm chippings and the tolerance increased to ± 1.5 kg/m².

† For relative densities outside the range given, the rate of spread shall be changed by 0.5 kg/m² for each 0.1 change in relative density.

NOTE 1. The rate of spread for chippings having a shape and size index different from those shown should be obtained by interpolation or extrapolation of the figures given.

NOTE 2. Size and shape index = Percentage of undersize + Flakiness index

Percentage of undersize is the percentage less than the nominal size as specified in BS 63.
Flakiness index as determined in accordance with BS 63.

NOTE 3. Recommendations for the measurement of the rate of spread of coated chippings are given in Appendix C.

When spreading the chippings, battens not less than 150 mm wide shall be placed against the kerbs so that a smooth channel is maintained to facilitate the flow of surface water to the gulleys.

**4.2.10 Rolling.** The asphalt shall be compacted as soon as rolling can be effected without causing undue displacement of the mixed material and while this has a temperature not less than the minimum given in Table 17. See also Appendix E.

NOTE 1. Rolling below the minimum temperature can fail to achieve proper compaction and adequate adhesion between layers.

NOTE 2. Rolling at too high a temperature can result in undue displacement of material and can cause unduly smooth texture on wearing courses.

The asphalt shall be uniformly compacted by a smooth steel-wheeled roller weighing not less than 8 tonnes and having a width of rear roll not less than 450 mm. The force per unit width of the rear roller shall be not less than 53 N/mm‡ of roll. The roller shall be fitted with a quick and smooth-acting reverse.

NOTE. Alternatively a multi-wheeled pneumatic tyred roller of equivalent mass may be used, except that wearing course and basecourse mixtures should be surface finished with a smooth steel-wheeled roller.

‡ 1 N/mm = 5.71 lbf/in.

### B.8 Alternative method for determining relative density

Relative density may be accurately and rapidly measured by means of a concentration-gradient density column as described in BS 3715. The method depends on the flotation of a particle of the material in a column of liquid, in which the density is graded over the required range. The procedure is as follows.

(1) Prepare a density-gradient column in a glass tube so that the relative density is approximately 1.00 at the top and 1.10 at the bottom. Distilled water and an aqueous zinc chloride solution with a relative density of approximately 1.1 afford suitable media for the column which should be about 1.0 m in length. Enclose the prepared density-gradient tube in a water jacket controlled at 25 ± 0.1 °C and keep the tube loosely covered when not in use to prevent evaporation. Calibrate the column by floating in it a series of glass spheres (3 mm to 4 mm in diameter) of known densities spaced uniformly over the range of the column.

(2) Prepare the sample for testing by pouring a ribbon of the well-mixed molten binder onto a flat sheet of silicone rubber. On cooling, cut a small piece (1 $mm^3$ to 2 $mm^3$) from the ribbon. Wet the pellet in a dilute solution of a surfactant to remove air bubbles. Prepare a minimum of three samples from one ribbon and test together.

(3) Introduce three separate pellets from each sample into the top of the density-gradient column. Normally they attain the same level; 'wild' results due to an included air bubble or to gross separation of the sample are immediately apparent and should be rejected. Introduce further pellets from the same sample until three pellets come to rest at the same level. Calculate the relative density of the sample from a previously constructed graph.

(4) Calculate and report as for the density bottle method.

## Appendix C

## Measurement of the rate of spread of coated chippings

### C.1 General

The application of coated chippings at the rate of spread specified in **4.2.9** can most conveniently and uniformly be obtained by a mechanical chipping spreader and the use of such a machine is particularly advisable for roads carrying high speed traffic.

### C.2 Measurement of the rate of spread of chippings for mechanical chipping spreaders

**C.2.1 Apparatus.** The apparatus consists of a shallow aluminium tray 300 mm square, secured by four short lengths of chain to a metal disc surmounted by a hook and a calibrated spring balance. The scale is calibrated in $kg/m^2$ with a range of 16 $kg/m^2$ to 4 $kg/m^2$. It is convenient to have at least 5 trays and preferably 10. All trays for use with one spring balance should be of equal mass.

Alternatively trays 600 mm square may be used: it is convenient to have at least 2 trays and preferably 4. A weighing device capable of weighing to within 10 grams is required (a spring balance is not suitable for this size of tray).

**C.2.2 Calibration.** The calibration of the spring balance for the smaller trays should be checked on each day of use or more frequently if error is suspected. This can be done by placing masses on the tray equivalent to the masses of chippings giving a low and high rate of spread, e.g. 7.5 $kg/m^2$ and 15 $kg/m^2$, and checking that the calibration of the spring balance is correct at these two rates.

**C.2.3 Procedure.**

(1) *300 mm square trays.* Five metal trays are laid, in echelon, in front of each half width of the chipping spreader and when the machine has passed over them, each tray with its quota of chippings is hooked onto and lifted by the spring balance and the rate of spread noted. The chippings on the tray are immediately returned to the vacant area on the road before the roller traverses that area. This is repeated to give ten readings for each half width of chipping spreader and the mean of these ten readings should be reported as the rate of spread for each half width.

(2) *600 mm square trays.* Two metal trays are laid in front of each half width of the chipping spreader and when the machine has passed over them the chippings from each tray are placed in a suitable container and weighed. The vacant area on the road should be re-chipped before the roller traverses the area. This is repeated to give four readings for each half width of the chipping spreader and the mean of these four readings should be reported as the rate of spread for each half width.

For both types of metal tray measurements of the rate of spread should be repeated:

*a.* for each new batch of chippings,
*b.* if visual observation indicates a change in the rate of spread,
*c.* if the machine is changed, or
*d.* at the discretion of the purchaser or his representative.

It is convenient to make preliminary adjustments to the machine by laying chippings on a clean, hard surface so that the rate of spread across the width of the machine can be determined and adjusted as necessary.

**C.2.4 Reporting of results.** The rate of spread of chippings should be reported as the average of either:

(1) each group of ten results for measurements made with 300 mm trays, or
(2) each group of four results for measurements made with 600 mm trays. The position across the width of the machine and the chainage on the road should also be given.

### C.3 Measurement of rate of spread of chippings spread by hand

The rate of spread of chippings may be determined from the mass of chippings used and the area of road covered by these chippings.

## Appendix D

## Notes on the use of this British Standard

### D.1 General

It does not fall within the scope of this British Standard to specify what grade of asphalt should be used under any given conditions. The most suitable grade of asphalt for a particular site depends upon many factors, particularly traffic, climate and the thickness of the asphalt to be laid; the correct choice requires knowledge and judgment on the part of the purchaser or his representative and of the contractor. The following notes are intended as a guide.

### D.2 Wearing course mixtures

**D.2.1 Asphaltic cement.** Prolonged storage of asphaltic cements at elevated temperature may result in hardening, this effect being particularly marked in pitch-bitumens. At no time should this binder be stored in bulk at temperatures in excess of 160 °C.

The range of temperatures (normally 150 °C to 205 °C but in the case of pitch-bitumen 150 °C to 185 °C) within which the coarse and fine aggregates should be heated prior to mixing with the asphaltic cements is specified in **1.6.** Hardening of all asphaltic cements will take place during the mixing process (and during the time of haulage to the laying site) and the upper limit of temperature 205 °C, or 185 °C when the binder is pitch-bitumen, is imposed to ensure that undue hardening does not occur. Control of temperature is important for all layers of construction with rolled asphalt and is of particular importance with wearing course materials.

Alternative grades of asphaltic cement are specified in Table 1, and whilst the selection of one of these is largely a matter of local experience the use of 50 pen binder will generally be found satisfactory in southern England, but there is a frequent preference for 70 pen binder for use in Scotland and northern England. See also Table 1, Note 1.

While an asphaltic cement of 50 pen is suitable for the great majority of situations, occasionally a harder material is needed for sites such as bus stops or other places where very heavy traffic is channelled. An asphaltic cement of 35 pen may then be used and should comply with the requirements given in columns 4 or 5 of Table 1.

# Appendix C

## 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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