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SURFACE DRESSINGS ON MOTORWAY HARD SHOULDERS

Results of experiments to determine optimum rates of spread of binder

by

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ABSTRACT

Surface dressing hard shoulders of motorways with light-coloured chippings is one method of providing a contrast in colour and texture with the carriageway. The rates of spread of binder suitable for normal surface dressings on roads are unsuitable for hard shoulders which carry little or no traffic. Two full-scale experiments were made on motorway shoulders to determine the optimum rate of spread. Tar and bitumen binders were used with $\frac{3}{8}$-in and $\frac{1}{4}$-in chippings, the rate of binder spread being varied. Dense tarmacadam base-course material could not be surface-dressed with $\frac{3}{8}$-in crushed-rock chippings as the necessary rate of spread of binder was too great for practical use; chippings not larger than $\frac{1}{4}$-in should be used. It was deduced that gravel chippings were unsuitable for surface dressing dense coated macadam base-course material.

1. INTRODUCTION

The bituminous surface of the paved hard shoulders of motorways is surface-dressed with chippings chosen to provide a surface with a light colour and a rough texture.

These hard shoulders carry little or no traffic and surface-dressing such areas requires heavier rates of spread of binder and, possibly, smaller sizes of chippings than are usually used on carriageways. This Report describes two experiments in which tar and bitumen were used, at various rates of spread, with both $\frac{1}{4}$-in and $\frac{3}{8}$-in chippings, the object being to find the best specification for surface dressing hard shoulders having two different types of surfacing.

2. EXPERIMENTAL SITES

2.1 Site A

One experimental series of surface dressings was laid on the M.4

(Slough By-pass) near the Slough Central junction. The shoulders were surfaced with a gravel-asphalt wearing-course material complying with B.S. 594.[1] This experiment was carried out in co-operation with the County Surveyor of Buckinghamshire.

2.2 Site B

The second experimental series was laid on the M.1 about one mile north of Crick junction (80 miles from London) where the shoulders were surfaced with a close-textured tarmacadam base-course material in accordance with Appendix 4 of Road Note No. 29.[2] This experiment was carried out in co-operation with the consulting engineers, Sir Owen Williams & Partners.

3. SCOPE OF EXPERIMENTS

On the two sites, sections of surface dressing were laid using both $\frac{3}{8}$-in and $\frac{1}{4}$-in chippings each for a range of rates of spread of both tar and bitumen binders. Details of the actual rates of spread as measured by the road tray test are given in Tables 1 and 2. All the dressings were rolled with pneumatic-tyred rollers.

3.1 Site A, on M.4

These sections, all 55 yards in length, were laid during cool weather in May, 1963. The gradings of the Leicestershire granite chippings used are given in Table 3 and show that the $\frac{3}{8}$-in size had some excess of oversized material and was very dusty. The dust undoubtedly caused some loss of chippings from parts of the dressings by sticking to the binder and preventing larger chippings from doing so. The tar used conformed to B.S. 76 [3] and had an equiviscous temperature of 38°C; the cutback bitumen was in accordance with B.S. 3690 [4] and had a viscosity of 80 seconds at 40°C (S.T.V.).

3.2 Site B, on M.1

These sections, each 80 yards in length, were laid in warm weather in July, 1964. Gradings of the limestone chippings, given in Table 3, show that the $\frac{3}{8}$-in size contained a considerable proportion of dust which often blinded the surface of the sprayed binder when gritting was in progress. The $\frac{1}{4}$-in chippings contained a very high proportion

of the nominal size. The tarmacadam base-course material on the hard shoulder was porous and rough-textured in some areas but comparatively smooth and dense in others. For these reasons the results, assessed from the loss of chippings, show some variability. The tar used was in accordance with B.S. 76 with an equiviscous temperature of 44°C and the cutback bitumen conformed to B.S. 3690, with 100 secs grade.

4. RESULTS

The experimental sections were inspected in the autumn and spring and the final results are given in Table 4. After only one winter there were very few sections of dressing in a satisfactory condition on Site B and it was obvious that the porous macadam base-course material required much more binder than the denser and smoother asphalt wearing-course material.

4.1 Application of the results

The experiments were carried out with crushed-rock chippings, and it would be expected that slag chippings require similar rates of spread of binder. When gravel aggregate is used in surface dressing on carriageways, the recommended rates of spread are heavier than with crushed rock. For hard shoulders, therefore, it is deduced that gravel should not be used on coated-macadam base-course material because very heavy rates of spread would be required and these would be difficult to achieve in practice. On dense asphalt rates of spread of binder should be $\frac{1}{2}$ yd^2/gal heavier than that for crushed rock.

5. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions were drawn from the results:

1. A successful surface dressing on a dense tarmacadam base-course material requires considerably more binder than one for an asphalt wearing-course material.
2. Very heavy rates of spread of binder, which would be difficult to achieve in practice, are required to hold $\frac{3}{8}$-in (or larger) crushed-rock or slag chippings to the base-course material.

3. The use of gravel chippings on dense coated macadam base-course is not recommended.

4. Recommended rates of spread of binder for the surface dressing of the two types of hard-shoulder surfacing are given in Tables 5 and 6.

6. REFERENCES

1. BRITISH STANDARDS INSTITUTION. British Standard 594:1961. Rolled asphalt (hot process). London, 1961 (British Standards Institution).

2. ROAD RESEARCH LABORATORY AND HIGHWAY ENGINEERING DIVISION. A guide to the structural design of flexible and rigid pavements for new roads. Ministry of Transport, Road Note No. 29. London, 1965 (H.M. Stationery Office) (Second edition).

3. BRITISH STANDARDS INSTITUTION. British Standard 76: 1964. Tars for road purposes. London, 1964 (British Standards Institution).

4. BRITISH STANDARDS INSTITUTION. British Standard 3690:1963. Bitumens for road purposes. London, 1963 (British Standards Institution).

TABLE 1

Sections of experimental surface dressing on asphalt wearing-course hard shoulder of M.4 near Slough Central junction (May, 1963)

West-bound hard shoulder (Bitumen binder - 80 seconds at 40°C)

Section No.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Non-experimental
Size of chippings (in)	3/8	3/8	1/4	1/4	3/8	3/8	1/4	1/4	1/4	3/8	1/4	1/4	3/8	3/8	1/4	1/4	
Bitumen binder (yd^2/gal)	4	4 3/4	4 3/4	4 3/4	5 1/4	-	6	7	4 1/4	4 1/2	4 1/2	5	5	5 1/4	5 1/4	4 1/4	

East-bound hard shoulder (Tar binder - 38° e.v.t.)

East West

Section No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Non-experimental
Size of chippings (in)	1/4	1/4	3/8	3/8	1/4	1/4	3/8	3/8	1/4	1/4	3/8	3/8	1/4	1/4	3/8	
Tar binder (yd^2/gal)	6 1/2	6	6	6 1/4	5 1/4	5 1/4	4 1/2	4	7	6	6	5	5	5 1/4	4 3/4	

TABLE 2

Sections of experimental surface dressing on dense tarmacadam base-course hard shoulder of M.1. one mile north of Crick junction (July, 1964)

North-bound hard shoulder

Section No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Non-experimental
Size of chippings (in)	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	
Rate of spread of binder (yd^2/gal)	$2\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{2}$	5	$6\frac{3}{4}$	$5\frac{1}{4}$	$4\frac{1}{4}$	$2\frac{3}{4}$	$3\frac{1}{2}$	4	5	6	$5\frac{1}{4}$	$4\frac{1}{4}$	$3\frac{3}{4}$	

South ← Bitumen (nominally 100 seconds at 40°) → | ← Tar (44° e.v.t.) → North

South-bound hard shoulder

Section No.	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	Non-experimental
Size of chippings (in)	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	
Rate of spread of binder (yd^2/gal)	$2\frac{3}{4}$	$3\frac{1}{2}$	4	5	$6\frac{1}{4}$	$5\frac{1}{4}$	$4\frac{1}{2}$	$3\frac{1}{2}$	$6\frac{1}{4}$	3	$3\frac{3}{4}$	4	5	6	$5\frac{3}{4}$	$4\frac{1}{4}$	

TABLE 3

Gradings of the chippings used for the experimental surface dressings

Nominal size of chippings (in)	B.S. sieve size (in)		Site A (M.4)	Site B (M.1)	Requirements of B.S. 63
	Passing	Retained			
			Per cent by weight		
$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{8}$	18.0	0.5	max. 15
	$\frac{3}{8}$	$\frac{1}{4}$	67.0	73.5	min. 60
	$\frac{1}{4}$	3/16	6.2	21.3	
	3/16	-	8.8	4.7	max. 10
	No. 7	-	2.6	2.5	max. 2
$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{4}$	12.0	7.0	max. 15
	$\frac{1}{4}$	$\frac{1}{8}$	74.0	89.2	min. 70
	$\frac{1}{8}$	No. 7	8.7	2.5	
	No. 7	-	5.3	1.3	max. 10
	No. 25	-	1.2	1.1	max. 2

TABLE 4

Results of inspections of experimental surface dressings on hard shoulders on M.4 and M.1

(a) Site A, M.4: surfaced with rolled-asphalt wearing-course material

Size of chippings (in)	Rate of spread of binder (yd^2/gal)	Inspection results after two winters	
		Bitumen	Tar
$\frac{3}{8}$	4	G-	FG/G-
	$4\frac{1}{2}$	FG-	FG/G-
	5	FG-	F/FG-
	$5\frac{1}{2}$	FG-	
	6		F-
$\frac{1}{4}$	4	G	
	$4\frac{1}{2}$	G (two)	FG-
	5	FG/G-	FG-
	$5\frac{1}{2}$		FG-
	6	FG-	F/FG-
	7	FG-	F/FG-

TABLE 4 (cont'd)

(b) Site B, M.1: surfaced with dense tarmacadam base-course material

Size of chippings (in)	Rate of spread of binder (yd^2/gal)	Inspection results after one winter	
		Bitumen	Tar
$\frac{3}{8}$	$2\frac{1}{2}$	G	G-
	3	FG-	
	$3\frac{1}{2}$	F/FG-	FG-
	4	F/FG-	FG-
	5	F-	F-
$\frac{1}{4}$	3		FG-
	$3\frac{1}{2}$	FG-	FG-
	4	FG-	F/FG-
	$4\frac{1}{2}$	F-to FG-	
	5	P-to F-	P-to F-
	6	B-	P-

B = bad
F = fair
FG = fairly good
G = good
P = poor
minus indicates a deficiency of binder

TABLE 5

Rates of spread of binder for surface dressing hard shoulders with crushed-rock or slag chippings

Size of chippings (in)	Asphalt wearing course (Site A, M.4)		Dense coated macadam base-course (Site B, M.1)	
	Bitumen (yd^2/gal)	Tar (yd^2/gal)	Bitumen (yd^2/gal)	Tar (yd^2/gal)
$\frac{3}{8}$	4	$3\frac{1}{2}$	$(2\frac{1}{2})$*	$(2\frac{1}{2})$*
$\frac{1}{4}$	$4\frac{1}{2}$	4	3	3

*This rate of spread is regarded as too heavy

TABLE 6

Rates of spread of binder for surface dressing hard shoulders with gravel chippings

Size of chippings (in)	Asphalt wearing course (Site A M 4)	
	Bitumen (yd^2/gal)	Tar (yd^2/gal)
$\frac{3}{8}$	$3\frac{1}{2}$	3
$\frac{1}{4}$	4	$3\frac{1}{2}$

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