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EFFECT OF RESISTANCE TO SKIDDING ON ACCIDENTS: SURFACE DRESSING ON ELEVATED SECTION OF M4 MOTORWAY

by
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ABSTRACT

Measurements of sideway-force coefficient carried out during 1967 and 1968 showed that the skidding resistance of the elevated section of the M4 Motorway had fallen to a relatively low level. Analysis of accident records also showed a high proportion of "skidding" accidents when the road was wet. The road was surface dressed during the summer of 1969 using aggregates that were expected to give a sustained high resistance to skidding. Before treatment the SFC ranged between 0.35 and 0.45 at 50 km/h. In the three years following treatment the range lay between 0.50 and 0.60. During the two years following treatment there has been a reduction of 45 per cent in the total number of accidents with an even greater reduction in the number of accidents in which skidding was reported to have occurred. The accident record of this road before and after surface dressing emphasises the close relation between resistance to skidding and accidents on busy roads, and the beneficial effect of remedial treatment with aggregate of high resistance to polishing in such situations.

1. INTRODUCTION

Measurements of sideway-force coefficient carried out during 1967 and 1968 showed that the skidding resistance of the elevated section of the M4 Motorway had fallen to a relatively low level. Analysis of accident records[1] also showed a high incidence of skidding when the road was wet. In view of this, the road was surface dressed during the summer of 1969, and this Report examines the effect of this work on resistance to skidding and on accidents.

2. RESISTANCE TO SKIDDING

Routine measurements of resistance to skidding (sideway force coefficient) made on the elevated section of the M4 Motorway at Brentford showed that by 1968 values had fallen well below 0.50 for SFC 50 km/h, the value regarded as desirable[2] at that time for this class of road (Table 1). Texture-depth measurements made in July 1969 on the eastbound carriageway indicated that adequate depth of texture remained (Table 2) but the exposed stone was highly polished and the surfacing had deformed in some local areas in the nearside lane.

The surface on both carriageways had been laid in 1965 using rolled asphalt to BS 594 (30 per cent coarse aggregate) with fluxed lake-asphalt binder and with 19 mm coated Bardon Hill chippings (PSV 59*);

* The values of PSV given throughout this Report apply to the chippings actually used during the work and do not necessarily apply in general to aggregates from the same sources.

it was subject in 1965 to a total daily traffic flow of 46,000 vehicles of which 7,500 were commercial. By 1970 the traffic flow had increased to a total of 74,000 vehicles of which 14,000 were commercial. In the intervening years the totals of traffic flow were approximately 1966 – 56,000; 1967 – 61,000; 1968 – 68,000; 1969 – 72,000. No data were available on commercial vehicles.

Following the skidding measurements made in 1968 the road was surface-dressed in the summer of 1969, the specification nominating a 1:2 blend of calcined bauxite (PSV 74*) with Gilfach gritstone (PSV 71*) and PVC-tar binder. Because supplies of calcined bauxite were limited at the time, only part of the eastbound carriageway of the elevated section was treated with this blend, Gilfach gritstone on its own being used on the remainder[3].

Measurements made immediately following treatment showed that the SFC had been raised to a mean value of 0.60 at 50 km/h. Since then the SFC in the offside lane has remained about that level and in the nearside lane, under the heavier traffic, it has fallen slightly. In any case the SFC has remained consistently well above that of the previous surfacing.

3. ACCIDENTS

The accident records on the elevated section of M4 for a period of 2 years before and 2 years after the surface treatment have been examined, the results of the analysis being given in Table 3. These include both injury and damage accidents.

The table shows that there were 45 per cent fewer accidents of all kinds during the 2 years following treatment than in the 2 years immediately preceding the work. On dry roads the reduction was 28 per cent and on wet roads 63 per cent.

Further examination of the table reveals that the reduction in accidents which involved skidding by one or more of the vehicles concerned was much greater than in accidents not involving skidding. On both dry and wet roads the reduction in skidding accidents was significantly greater than the reduction in accidents not involving skidding (see Table 3). On dry roads the reduction in skidding accidents was 54 per cent and in non-skidding accidents 18 per cent : on wet roads the corresponding percentages were 75 per cent and 40 per cent.

4. OTHER RELEVANT FACTORS

There are a number of other environmental factors which should be noted.

1. In its layout and in the absence of hard shoulders this overhead section of the M4 is urban rather than rural.

2. During the period under review there were some other road changes, namely:–
   (i) Work on installing lighting and barriers on the adjacent length between the elevated section and London Airport commenced November 1966 and was completed March 1968.
   (ii) Between May and September 1968 parts of the nearside lane of the elevated length were closed on weekdays between 8 p.m. and 7 a.m. for modifications to the rails.
   (iii) Some hatching was painted on the offside lane of the 3-lane road adjacent to the elevated section.

However, it is considered that these are unlikely to have had any substantial effect on the comparison of accidents in the before and after periods on the elevated length of M4.

3. Remotely controlled signals were installed in March 1969, but although no assessment of the benefits of these has been made, any effect they may have had in reducing accidents must be small compared with the effects demonstrated here, because the signals are on average in operation only 0.6 hours per month.

4. A summary of weather data recorded at Heathrow over the period 1967–1971 is given in Table 4. There are no unusual weather features which could have accounted for a reduction in accidents in the second half of the period.

5. CONCLUSIONS

The investigation described above shows that surface dressing the elevated section of M4 led to an immediate increase in the SFC, and that during the following 2 years there was a marked and significant reduction in the number of accidents on both wet and dry roads.

During the period following treatment, the SFC has varied in the usual seasonal way but, over the three years, values have been maintained at reasonably high levels. The skidding-accident record of this road before and after surface dressing emphasizes the close relationship between resistance to skidding and accidents on roads subject to fast and heavy traffic, and the beneficial effects of remedial treatment with aggregate of high resistance to polishing.

6. ACKNOWLEDGEMENTS

The investigation described has been carried out by Materials Division (Head of Division : Mr. G.F. Salt) and by Accident Analysis Division (Head of Division : Miss B.E. Sabey), of the Highways and Safety Departments respectively.

7. REFERENCES

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TABLE 1

M4 elevated section
sideway force coefficients at 50 km/h

Direction	Lane	Before treatment		After treatment						
		1967	1968	1969	1970		1971		1972	
				Gilfach	Gilfach	Gilfach + Bauxite	Gilfach	Gilfach + Bauxite	Gilfach	Gilfach + Bauxite
Eastbound	Nearside	0.42	0.36	0.60*	0.48	0.59	0.49	0.63	0.52	0.54
	Offside	0.46	0.38	0.56*	0.57	0.63	0.57	0.67	0.53	0.60
Westbound	Nearside	–	0.34	0.62	0.52	–	0.49	–	0.50	–
	Offside			0.61	0.57	–	0.53	–	0.55	–

* Mean value of both surfaces. Separate values for Gilfach and mixtures of Gilfach and Bauxite not available.

TABLE 2

M4 elevated section – eastbound carriageway
texture depth measurements (mm)

Lane	Before treatment	After treatment			
	July 1969	September 1969		February 1972	
		Gilfach	Gilfach + Bauxite	Gilfach	Gilfach + Bauxite
Nearside	1.17	1.06	2.34	0.90	1.55
Offside	1.34	2.02	2.12	1.46	1.79

TABLE 3

Before treatment 1/7/67 – 30/6/69 — Accidents on elevated length of M4 (Main carriageway only)

Class of accident	Dry roads					Wet roads					Snow/ice			Not known			Total accidents
	With skid (a)	With-out skid (b)	Total a + b	Per cent with skid	Not known whether skid occurred	With skid (a)	With-out skid (b)	Total a + b	Per cent with skid	Not known whether skid occurred	With skid	With-out skid	Total	With skid	With-out skid	Total	
Fatal	–	1	1		–	–	–	–		–	–	–	–	–	–	–	1
Serious injury	1	2	3		–	–	–	–		–	–	–	–	–	–	–	3
Slight injury	15	40	55		1	27	15	42		1	3	–	3	–	–	–	102
All injury	16	43	59	27	1	27	15	42	64	1	3	–	3	–	–	–	106
Damage only	30	85	115		13	61	30	91		3	1	1	2	1	1	2	226
All accidents	46	128	174	26	14	88	45	133	66	4	4	1	5	1	1	2	332

After treatment 1/9/69 – 31/8/71

Fatal	–	–	–		–	–	–	–		–	–	–	–	–	–	–	–
Serious injury	1	3	4		–	1	2	3		–	–	–	–	–	–	–	7
Slight injury	7	32	39		1	7	7	14		–	–	–	–	–	–	–	54
All injury	8	35	43	19	1	8	9	17	47	–	–	–	–	–	–	–	61
Damage only	13	70	83		5	14	18	32		–	1	–	1	–	–	–	121
All accidents	21	105	126	17	6	22	27	49	45	–	1	–	1	–	–	–	182
% reduction in No's of accidents																	
Injury	50	19	27			70	40	60									42
All	54*	18*	28			75†	40†	63									45

*percentage significantly different at the 5% level

†percentage significantly different at the 1% level

TABLE 4

Summary of weather data recorded at Heathrow

	1967	1968	1969	1970	1971
Rainfall (terminal hour 9 GMT)					
Amount (mm)	699	755	564	656	619
Percentage of 1916–50 average	116	125*	93	109	102
Snow or sleet (number of days)					
Snow or sleet (midnight-midnight GMT)	17	25	37	35	17
Snow lying at 9 GMT	5	7	7	11	1
Bright sunshine					
Daily mean (hr)	4.49	3.63	4.07	4.33	≃4.21*
Fog (number of days)					
Visibility <1000 metres at 9 GMT	3	6	11	6	18
Visibility > 400 metres at 3 GMT	5	2	8	5	13
Visibility > 400 metres at 9 GMT	1	4	6	6	12
Visibility > 400 metres at 15 GMT	0	0	1	1	3
Visibility > 400 metres at 21 GMT	1	2	4	2	3
Visibility < 200 metres at 3 GMT	3	1	4	1	6
Visibility < 200 metres at 9 GMT	0	2	5	4	8
Visibility < 200 metres at 15 GMT	0	0	0	1	3
Visibility < 200 metres at 21 GMT	1	2	2	2	2
Air temp (°C) difference from 1931–60 average	+ 0.2	− 0.1	+ 0.1	+ 0.3	≃0.4*

NOTE: These data were obtained from Monthly and Annual summaries of the Monthly Weather Report of the Met. Office, published by HMSO.

* Not published values but estimates from available data.

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