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RESEARCH LABORATORY**

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**SURFACE DRESSING:
A SURVEY OF WINDSCREEN DAMAGE**

by

N. Wright

**Any views expressed in this Report are not necessarily
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**Materials Division,
Highways Department,
Transport and Road Research Laboratory
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SURFACE DRESSING : A SURVEY OF WINDSCREEN DAMAGE

ABSTRACT

Questionnaires about the rate of windscreen breakage on new surface dressings on heavily trafficked roads (mostly rural) were sent in March 1971 to selected County authorities. An analysis of data received from eleven counties shows the extent of the problem.

The greatest number of breakages occurred in the first week after laying the dressings and the total was independent of the size of the chipping used within the range 10 mm to 12.7 mm. Approximately three windscreens were broken for every 100,000 vehicle kilometres during this first week. In the next three week period the rate of breakage was 0.41 and thereafter was little different on the sections which had been dressed from that on untreated roads (some 0.33 breakages for 100,000 vehicle kilometres). Significantly higher rates of breakage were found on surface dressed sites longer than 3 km than on shorter sites.

No conclusive evidence was found to suggest improved performance with either lightly coated or uncoated chippings. Contrary to expectations, lower levels of windscreen breakage were found on sites where steel-tyred rollers were used in preference to rubber-tyred rollers. The effect of using steel-tyred rollers on surface texture depth (an important factor in maintaining resistance to skidding at high speeds) requires further investigation.

1. INTRODUCTION

Surface dressing has for many years been a cheap and effective process for improving resistance to skidding and for providing general protection to the road structure. Few difficulties are experienced on minor roads carrying only light, relatively slow-moving traffic, but when the process is extended to more important roads, where traffic is heavier and moves at much faster speeds, problems arise from windscreens being broken by flying chippings.

Limited financial resources are available for maintenance and surface dressing is increasingly being used on high-speed roads as it is a low-cost and basically simple form of treatment. The next cheapest form of surface treatment costs in the region of four times as much as surface dressing, so the advantages to be gained from continuing this type of treatment are evident.

During the summer of 1970 it became apparent that windscreen damage on surface dressings was causing increasing concern amongst County authorities and adverse comment from the motoring public. The Laboratory with the ready co-operation of a number of County Surveyors throughout the United Kingdom, proposed to examine the extent of windscreen damage on surface dressings on high-speed roads and if possible to indicate how such damage could be kept to reasonable levels. At the same time information was also to be sought regarding the extent of windscreen breakages on similar categories of road which had not been surface dressed.

This Report describes the work.

2. METHOD

Initially, a letter (reproduced in Appendix 1) was sent to 12 County Surveyors inviting their participation in the investigation. Response to this appeal was enthusiastic and a meeting of the representatives of the County Authorities was held at TRRL in December 1970 to discuss the detailed arrangements for the scheme.

At this meeting it was agreed that the investigation should take place over approximately 16 km of roads scheduled for surface dressing as part of each Authority's normal work, and also over 10 km of untreated road as controls. The controls were to be separated geographically from the surface dressing lengths, but were to be on the same road to ensure that the comparison was made at the same level of traffic flow. The further condition was imposed that the control section should not have been surface dressed within the last two years. In both cases the minimum length of section would be 1 km.

It was also agreed that counts of the numbers of windscreens broken on each section would be made from visual evidence of glass on the roadside. There is some inherent risk of inaccuracy in this method as at times motorists may travel some distance before completely removing damaged windscreens. This risk is particularly high for short sections and to reduce error arising from this cause observations were also to be made for at least 500 m beyond the surface dressing in either direction and further checks made at the next obvious stopping point. These risks were considered acceptable in view of the broad terms of the survey.

Arrangements were made for TRRL to be informed of any untoward occurrence resulting in exceptionally large numbers of breakages being reported. Two such incidents arose and the results of investigation into the causes of failure of these surface dressings are given later.

Following this meeting a series of forms (reproduced in Appendix 2) were prepared to record the information required. Form MSD 1 was designed to record in detail the conditions under which the surface dressing work was carried out. Information was sought on the detailed specification for materials, the condition of the existing surface, weather conditions and particularly the degree of aftercare provided. Forms MSD 2 and 3 served to record the numbers of windscreens broken on both the trial and control lengths. On the surface-dressing sections counts were required daily for the first week, weekly for the next three weeks and monthly thereafter to the end of the year. Control sections were checked monthly throughout the same period.

3. RESULTS AND DISCUSSION

The survey took place during the 1971 surface-dressing season (April-October) and replies were received from 11 of the 12 authorities invited to take part. A total of 70 surface-dressing sites and 57 control sites were included in the investigation; these covered 142.5 and 92.8 kilometres of road respectively.

To provide a standard of comparison the numbers of windscreens broken on lengths of road not subjected to surface dressing (the "control" sections) were first evaluated. 68 breakages were reported in one month; these breakages occurred reasonably uniformly over the period. No windscreen breakages on control sections were reported from two of the co-operating counties; one further county did not provide data on control sections.

The vehicle occupancy of the control sections of road was found to be 683,000 vehicle-kilometres a day and the average number of breakages was therefore 0.33 breakages for each 100,000 vehicle-kilometres. Earlier estimates of windscreen breakages⁽⁵⁾ showed one breakage to occur for every 480,000 vehicle-kilometres on all types of surfacing. The present survey shows one breakage for every 300,000 vehicle-kilometres.

Numbers of windscreens broken on the surface-dressed sections for individual counties are also expressed in terms of breakages for each 100,000 vehicle-kilometres and are shown graphically in Fig. 1. They are recorded for each week in the first four-week period and subsequently monthly. The average rate of breakage for all eleven counties (the 'survey average') is shown both for the first week and for the next three weeks after laying the dressings. The average for the untreated "control" sections is also given.

Data from the survey is considered in detail in the following sections.

3.1 Type of carriageway

By far the largest number of roads in the survey were of the 2-lane single-carriageway type; these formed 86 per cent of the total. The remaining 14 per cent consisted of 3- and 4-lane single carriageways and 2-lane dual carriageways. Table 1 shows the numbers of windscreens reported as broken on each type of road. The high number of breakages on the 3-lane single carriageway is due to one site recording 22 breakages in one week. This road carried very fast-moving traffic, and it has been suggested that the high number of breakages was due to fast moving traffic travelling in the centre lane flicking up loose chippings in the path of vehicles travelling in the opposite direction.

Apart from this one site, the number of windscreen breakages appears to be little influenced by the type of carriageway.

3.2 Type of old road surface and hardness of substrate

Each co-operating authority was asked to define the type of road surface on which the new surface dressing was to be applied. In 66 per cent of the cases the substrate was a previous surface dressing; 24 per cent were macadams, with 7 per cent rolled-asphalt and 3 per cent cold-asphalt wearing-courses. Although the percentage of asphalt surfacings is small, there is some indication that numbers of windscreen breakages, particularly in the first week after laying, were slightly higher on these substrates than on others.

It has been accepted for many years that an essential preliminary to deciding specifications for surface dressings is a site inspection to assess the hardness of the old road surface. At the time of this survey, current recommendations for surface dressing^(1,2) suggested the division of road surfaces into three main categories depending upon estimates of subsequent embedment of chippings under traffic. The categories were hard, normal and soft, and as no quantitative method was available, the experience of the local engineer was of considerable importance in arriving at correct assessments.

Incorrect assessment of hardness can cause considerable difficulty in surface-dressing work. For example, 14 mm chippings would now be appropriate for a normal surface under certain traffic conditions, but should the decision be wrong and the surfacing turn out to be hard, there would be serious risk of displacement of chippings by traffic as little or no embedment of chippings would occur.

In view of the large number of substrates reported as being old surface dressings, it is surprising that in no case was a surface assessed as “soft”. The surfaces to be treated were considered as “hard” in 30 per cent of the cases and “normal” in the remaining 70 per cent.

No significant difference in numbers of windscreen breakages could be determined in the two categories (Tables 2 and 3).

3.3 Effect of roller type

One of the main objects of surface dressing on high-speed heavily trafficked roads is to re-texture the road surface to restore resistance to skidding. The degree of surface texture depth imparted by a new layer of aggregate is particularly important in reducing the risk of skidding at high speeds and minimum levels of texture depth have been proposed⁽³⁾. It has been suggested that the use of steel-tyred rollers to consolidate surface dressings tend to cause some crushing of the aggregate with consequent reduction of texture depth. To avoid this loss of texture, the use of rubber-tyred rollers is widely advocated.

On the other hand, it is sometimes claimed that there is an advantage in the action of steel rollers in crushing oversize chippings as this may reduce the number of flying chippings generated by traffic.

Co-operating authorities were asked to state the rolling techniques adopted on each site and these are summarised in Table 4. Rubber-tyred rollers were used on 30 per cent of the sites, steel rollers on 20 per cent and both types were used in combination on the remaining 50 per cent of the sites.

The average number of windscreens broken per site in the first week after applying the surface dressings is significantly lower (1.8 per site) on those sites employing solely steel-tyred rollers than on sites where either rubber-tyred rollers only were used (4.2 per site) or where both types were used in conjunction (3.1 per site). The numbers of windscreens reported as broken in the first week are equivalent to one breakage every 47,000 vehicle-kilometres on the steel-roller sites and every 31,000 vehicle-kilometres for the remaining sites.

This finding reinforces the opinion held in some quarters that steel-tyred rollers reduce the number of flying chippings generated by traffic from surface dressings in high-speed roads. Further investigation needs to be made to determine quantitatively whether any reduction in surface texture depth results from their use, compared with rubber-tyred rollers.

3.4 Methods of sweeping and traffic control

The quantity of chippings applied to the surface dressing must be sufficient to cover the entire surface of the sprayed binder film after rolling. The most reliable way of ensuring complete cover is to lay a slight excess and achievement of just the right amount of excess has always been a problem. It is the excess chippings, together with any chippings subsequently loosened by traffic, that may prove dangerous if flung about. Control of traffic speeds can materially reduce this problem.

Accordingly the co-operating authorities were asked to submit details of the methods adopted to remove loose chippings and of the method of traffic control employed (Tables 5 and 6). On 9 per cent of the sites no removal of chippings was undertaken and on 40 per cent of the sites no traffic-control measures were enforced. The most widely used method of traffic control was by flagmen controlling two-way traffic on that part of the road not being surface dressed at the time. Control of traffic speeds over the new dressing was imposed in only 4 per cent of cases and it was considered that insufficient evidence on this point was available for meaningful conclusions to be drawn.

The investigation showed that suction sweeping was the preferred method of removing surplus chippings, it being used on 91 per cent of the sites. Surplus chippings were not removed on the remaining sites; apparently traffic was relied upon to scatter the chippings towards the sides of the road.

There was some variation in the sweeping routines involved. In almost 16 per cent of the cases, suction sweeping took place immediately following rolling and was not repeated later. Suction sweeping was deferred until the end of the day's work in 31 per cent of cases, again with no further sweeping. Presumably traffic continued over the dressing at this time; no separate counts of windscreens broken in the pre-sweeping period were available. In 44 per cent of cases sweeping was carried out after work finished and again on subsequent days. It was not clear from replies whether subsequent sweeping was carried out as a matter of routine, or because loose chippings were known to be present.

In general, no significant differences in numbers of windscreen breakages could be attributed to any particular regime of sweeping and traffic control.

3.5 Effect of chipping size

During this investigation no restriction was placed on the specification for surface dressing to be used by the co-operating authorities; they continued to specify materials currently in use in their areas. Two sizes of surface-dressing chipping, 12.7 mm ($\frac{1}{2}$ in) and 10 mm ($\frac{3}{8}$ in) were used on all the sections surveyed. 6 mm ($\frac{1}{4}$ in) chippings were used on one occasion on the centre lane of a three-lane carriageway and also for the first dressing of a double surface dressing.

The 12.7 mm and 10 mm chippings were used in almost equal proportions, 12.7 mm chippings being used on 36 sites and 10 mm on 34 sites. Two counties used exclusively 12.7 mm chippings and a further two restricted their choice to 10 mm size only.

Table 7 shows the relative numbers of windscreens reported broken with both sizes of chipping. It should be remembered that the sizes of chippings used on this work conformed essentially to the gradings and nominal

sizes set out in BS 63: 1951 for Imperial units. The metric version of this standard results in the nominal $\frac{1}{2}$ in chipping becoming 14 mm, a significantly larger size than used previously.

The pattern of breakages reported is very similar for both chipping sizes and it is interesting to note that this general pattern is followed both in the week immediately following the surface-dressing operation and during the next three week period. During the first week of the lives of the dressings, 114 windscreens were broken on 36 sites where 12.7 mm chippings were used, an average of 3.1 per site. Almost exactly the same average rate was found over a similar period where 10 mm chippings were used. This breakage rate is equivalent to one breakage every 32,000 vehicle-kilometres with 10 mm chippings and every 33,000 vehicle-kilometres with 12.7 mm chippings.

This leads to the conclusion that, over the fairly narrow range of size of surface-dressing chippings used in this investigation, the effect of differences in chipping size on rate of windscreen breakage is not significant. 17 mm and 20 mm sized chippings are increasingly being used in the nearside lanes of carriageways in lane traffic categories 1 and 2 (over 2,000 and 1,000–2,000 commercial vehicles per day per lane in one direction respectively). Under these circumstances the dressing may be vulnerable to chipping loss early in its life, although this risk is lessened as embedment of chippings into the substrate takes place under the action of heavy vehicles. Further investigation is required on rates of windscreen damage where these large chippings are used.

3.6 The use of lightly coated chippings

Chippings lightly coated with a film of hardened binder are widely used in surface dressing. The coating process eliminates surface dust and enables rapid adhesion to the sprayed binder film to be achieved. Such chippings were used on the greater proportion of the sites in this survey.

Of the 36 sites where 12.7 mm chippings were used, they were used in the uncoated state on only 3 sites. Similarly uncoated chippings were used on only 7 of the 34 sites where 10 mm chippings were specified. Thus in both cases the size of sample of sites where uncoated chippings were used is small, and this paucity of data makes it difficult to distinguish clear differences between lightly coated and uncoated chippings.

Table 8 shows that on the sites where uncoated 12.7 mm chippings were used higher numbers of windscreens were broken than on the sections using lightly coated chippings of the same size. Conversely, the rather larger sample of seven sites using 10 mm uncoated chippings shows the number of breakages to be appreciably *less* than with lightly coated chippings. The same pattern emerges when the breakages in the next three-week period are considered.

It has been suggested that in periods of extremely hot weather during the surface-dressing operations (or immediately after laying), lightly coated chippings are more susceptible to “whip-off” under traffic than uncoated chippings. This may be attributable to higher road-surface temperatures developing on black surfaces than on lighter coloured surfaces. High road temperatures were reported from three sites soon after laying; no significant difference from the number of breakages reported from other sites was apparent.

3.7 Effect of wet weather — adhesion failures

Even when surface dressing is carried out by the correct technique, failures of newly-laid surface dressings may be caused by rain displacing the binder from the chippings which are then whipped off by traffic. This additional source of loose chippings presents a further hazard to vehicle windscreens. Accordingly adhesion agents are sometimes incorporated into binders prior to spraying to promote good adhesion between the applied chippings and the sprayed binder film, particularly if wet weather is imminent. In this survey, such wetting agents were used on three sites with 12.7 mm chippings (1 lightly coated, 2 uncoated) and on six sites with 10 mm chippings, all of which were used uncoated.

Only four breakages were reported over the period of the survey from the 6 sites with 10 mm chippings; this is below the national average for all 10 mm sites. No breakages were notified from two of the 12.7 mm sites, but a total of 17 were reported from the third, including 7 in the first week after laying. Although uncoated chippings were used on this site the weather was reported as dry for the 48 hours following spraying. It would appear unlikely, therefore, that adhesion problems contributed to this high rate of windscreen breakage.

One case of complete adhesion failure due to wet weather was reported. This occurred when 10 mm chippings (uncoated) were used without an adhesion agent in the binder and when heavy and continuous rain followed shortly after applying the dressing. Remedial treatment was carried out as soon as possible as almost all the applied chippings were lost. Three windscreens were reported as broken prior to re-surfacing and this site was excluded from the survey.

Loss of chippings due to poor adhesion in wet weather cannot be considered as presenting a serious problem in this survey.

3.8 Effect of binder type and viscosity

Five different types of binder were used during the surface-dressing work, the two main categories being cut-back bitumen and tar-bitumen blend, which together accounted for 84 per cent of the total. These two binders have been further divided according to viscosity grade and details of their use are given in Table 9.

This indicates that the number of windscreen breakages with cut-back bitumen is slightly higher during both the first week and the next three weeks than with the other binders although the data available for tar, PVC-tar and bitumen emulsion binders is sparse. No clear pattern emerges regarding the time of year in which particular cut-back bitumen viscosities are chosen; both viscosities were used right through from April to September.

The recommendations for surface dressing with cut-back bitumen given in Road Note 38⁽²⁾ (now replaced by Road Note 39⁽⁴⁾) suggest that 200-sec-viscosity grade cut-back bitumen should be used only during the months of June, July and August. The use of 100-sec-viscosity grade is recommended for earlier and later months. In this survey it was found that the lower viscosity binder was used in 50 per cent of the cases during the warmer summer months. This may have had a bearing on the slightly worse results obtained with this binder.

On the other hand, there is a clear distinction between the use of low and high-viscosity tar-bitumen blend. No binder in the grade 48/52° evt was used on any site before June, and in only one case (in August) was the lower viscosity grade (44/46° evt) used later than June. In June, both viscosity grades were used in almost equal proportions; the lower grade was used exclusively in counties situated in the north of England.

3.9 Effect of length of road site

The view has often been expressed that if several kilometres of road are surface-dressed in one operation, drivers tend to become impatient of delays, speeds rise and broken windscreens result even on the most carefully applied dressings.

This survey included 10 lengths of surface dressing each 3 km (2 miles) or more in length. These lengths are significantly longer than the average length of the remaining 60 sites (just over 1.6 km) and the opportunity was therefore taken to test the view expressed above by a detailed examination of the rates of windscreen breakage found on these longer sites.

It has been estimated⁽⁵⁾ that with the current type of toughened-glass windscreen one breakage occurs for every 480,000 kilometres of motoring on all types of road surfacing carrying heavy traffic. (The present survey indicates that the figure may now be 300,000 kilometres.) From the first estimate Millard⁽⁵⁾ has concluded that if more than five windscreens are broken per mile (say 3 per km) in the month following surface dressing on roads carrying 10,000 vehicles a day, this must be considered unacceptable. This corresponds to a figure of one breakage for every 100,000 vehicle-kilometres covered and will be taken as the maximum that may be tolerated during surface-dressing operations. It amounts to three times the rate of breakage found in this survey for a comparable number of vehicle kilometres on control sites.

Table 10 compares the number of windscreen breakages considered as just acceptable according to the arbitrarily chosen value with the numbers actually counted.

This shows that at all times the rate of windscreen breakage following surface-dressing is greater on the longer sites than on the shorter. During the first month the rate of breakage occurring on short sites is just acceptable, whereas an unacceptable rate occurred in the long sites. More significant however, is the very high level of breakage on both types of site in the first week after surface-dressing. The rate of breakage for the long sites is more than 3½ times, and on the short sites almost 3 times the rate considered as only just acceptable to the motoring public. There is clearly a pressing need for a very much improved measure of aftercare both immediately after laying and on each of the next few days.

3.10 Time of year when dressings were applied

Road Note 39(4) recommends that surface-dressing operations on heavily trafficked roads (in particular in lane traffic categories 1 and 2) should be restricted to the period mid-May to mid-July. This permits higher-viscosity binders to be used as the dressings will become stabilised by partial embedment of chippings under traffic during the summer months. This tends to reduce the risk of loss of chippings which might occur during the following winter.

An analysis was, therefore, made of the months of the year during which the surface dressings considered in this survey were laid. The results are listed in Table 11. About half of the dressings were laid between 1 May and 30 June, some 16 per cent in July and 19 per cent in August. The amount of dressing carried out early and late in the season (April, September and October) amounted to a further 16 per cent.

It is sometimes suggested that bitumen emulsions are particularly suited to work early and late in the season when road surfaces may be expected to be damp. This advantage was not apparently utilised, as this binder was used on three of the more lightly trafficked sites, one in mid-May and the other two in July.

Table 11 indicates that the numbers of windscreen breakages in the first week after laying are rather higher than normal for May and August. In May the number of windscreens broken per site in the week after laying was 3.3; in August the figure rose to 4.7 compared with the average for all roads of 3.1. The highest number of breakages per site in the next three weeks following surface-dressing occurred in July where the number of breakages continued at an average of 2.6. Some part of the three-week period extended into August and this tends to reinforce the suggestion that breakages during August rose appreciably higher than at other times. This may be due to an increased percentage of private cars travelling during holiday periods.

This suggests that local Authorities wishing to reduce complaints from the motoring public might consider adopting the practice already in vogue in some tourist areas of stopping surface-dressing work on major routes during the main holiday period.

4. INVESTIGATION INTO THE REASONS FOR FAILURE OF TWO DRESSINGS

Serious damage to windscreens was reported from two sites originally included in the general survey. Detailed investigations were made to determine the causes of failure and as a result of the investigations the two sites have not been included in the survey.

4.1 Site 1

On this site no fewer than 159 windscreen breakages were reported in the first month; of these, 39 occurred during the week after laying, a further 30 in the next three weeks and it was reported that 90 windscreens had been broken during the nine-day period in late May when the work was being carried out. This latter figure must be considered as an estimate.

The road concerned is a 3-lane single carriageway, 6.4 km long carrying 14,500 vehicles per day. The majority of these vehicles were private cars travelling at very high speeds. The specification called for 12.7 mm chippings with cut-back bitumen applied at a rate of 1.2 litre/m². The old road surface was dense bitumen macadam which it was assumed would offer normal resistance to penetration of chippings under traffic. Making this assumption, the specification was technically correct.

However, more detailed examination of the substrate showed it to be very hard and also to be rather porous. This was confirmed some three months after laying the dressing, as very little embedment of chippings had occurred in spite of periods of very hot weather. It was established that the newly applied dressing had been swept prior to opening to unrestricted traffic. It is probable that less damage would have occurred had the dressing been re-swept after the passage of relatively slow moving traffic as this action is known to accelerate the removal of chippings only partially held by the binder film.

It was concluded that too large a chipping had been specified for the traffic conditions and for the rate of binder applied when the substrate was in the hard or very hard category.

4.2 Site 2

Work on this site took place on two days in early August on a 2 km length of a 2-lane single-carriageway road carrying 5,000 vehicles per day. The old road surface was a previously surface-dressed macadam, considered as being of normal hardness and the new surface-dressing consisted of 12.7 mm chippings with bitumen emulsion binder.

Serious difficulties arose after the second day's work when considerable loss of chippings occurred. 34 windscreens were reported broken during the next two days. Investigations made by the local authority showed the cause of failure to be faulty binder which could not be sprayed properly, leading to insufficient binder being applied. Owing to lack of experience on the part of the contractor, spraying was continued whilst rain was actually falling and this resulted in almost total loss of chippings from some parts of the road. The substrate was later discovered to be hard rather than of normal hardness and 10 mm chippings would have been preferable. The entire area was later burned off and resurfaced with bitumen macadam.

As previously stated, it was felt that the inclusion of these two sites would unduly weight the survey average. However, it is in extreme cases such as these that the incidence of broken windscreens has to be eliminated or drastically reduced. County authorities can rarely afford the manpower to exercise the very stringent level of supervision needed to control inexperienced operators. It would appear prudent, therefore, in view of the undoubted variation in expertise of available surface-dressing contractors, to restrict work on heavy-trafficked roads to contractors of proven experience and capability.

5. CONCLUSIONS

The following conclusions have been drawn from the evidence obtained from the survey.

1. The survey shows that the greatest number of windscreens are broken in the first week after laying new surface-dressings. Damage is independent of chipping size within the narrow range (10 mm to 12.7 mm) examined. The average for the 11 counties included in the survey was just over three breakages for every 100,000 vehicle-kilometres in this period. In the next three week period the rate of breakage was 0.41; subsequently it did not differ significantly from the normal incidence of windscreen damage on untreated roads which was found to be 0.33 breakages for every 100,000 vehicle-kilometres.

It is concluded that for surface-dressings to be acceptable to motorists when used on heavily trafficked, high-speed, roads considerably more attention must be given to techniques for removing surplus or loose chippings in the immediate post-dressing period.

2. The length of the section of road being surface-dressed has been found to be an important factor contributing towards high rates of windscreen breakage. The rate of breakage on sites longer than 3 km was significantly higher than on shorter sites. This finding was also independent of chipping size within the narrow range examined.

The effect of traffic speed was not assessed, but high speeds on long sections of new dressing may be expected to lead to higher breakage rates.

3. Significantly lower levels of windscreen breakage have been found in this survey on the 20 percent of sites

where steel-tyred rollers were used rather than those with rubber tyres. The risk of damage is also lessened when both types of roller are used in combination. This finding is independent of length of site.

Further research is required to determine quantitatively whether any reduction in surface texture depth of the dressings results from the use of steel-tyred rollers.

4. The use of lightly coated chippings for surface-dressing was widespread; they were used on over 85 per cent of the sites. Windscreen breakages occurred with both lightly coated and uncoated chippings. Conclusive evidence of improved performance with either type was not obtained.
5. Users of cut-back bitumen tended to be less selective in the choice of binder viscosity appropriate to the time of year dressings were carried out than those using other binders. Windscreen breakages on roads surface-dressed with cut-back bitumen were slightly higher than average during the first week after laying and significantly higher over the next three-week period than with the next most widely used binder, which was tar-bitumen blend. This may well be due to indiscriminate use of a range of viscosities of cut-back bitumen over the whole season, April to September, whereas the higher viscosities of tar-bitumen blend were reserved for the June-August period.
6. The weather during the 1971 surface-dressing season was generally dry with two short periods of hot weather. Little indication was found of damage due to hot weather after laying the dressings. There was some evidence indicating that breakages in the first week after laying were slightly higher in May and August than in other months.

6. ACKNOWLEDGEMENTS

The Laboratory wishes to acknowledge the valuable help given by individual County Surveyors in the undertaking of this survey and is grateful to all of their staff who co-operated by filling in the questionnaires.

Counties taking part were Berkshire, Derbyshire, Dorset, Glamorgan, Hampshire, Huntingdon and Peterborough, Kent, Lancashire, Northamptonshire, West Riding of Yorkshire and Worcestershire.

This Report was prepared in the Materials Division (Head: Mr. G. F. Salt) of the Highways Department.

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TABLE 1

Type of carriageway

Number of sites	Type of carriageway	Windscreen breakages (No.)	
		1st week	next 3 weeks
60	2-lane Single	171	69
3	3-lane Single	24	9
2	4-lane Single	6	1
5	2-lane Dual	20	4
70		221	83

TABLE 2

Type of old road surface prior to surface-dressing

Number of sites	Type of old road surface	Windscreen breakages (No.)	
		1st week	next 3 weeks
5	Rolled asphalt	34	12
2	Fine cold asphalt	3	0
17	Coated macadam	33	11
46	Previous surface-dressings	151	60
70		221	83

TABLE 3

Estimated hardness of substrate

Number of sites	Condition	Windscreen breakages (No.)	
		1st week	next 3 weeks
21	Hard — Resists penetration of chippings	72	24
49	Normal — Slight embedment of chippings expected	149	59

TABLE 4

Type of rolling technique employed

Number of sites	Type of roller	Windscreen breakages (No.)	
		1st week	next 3 weeks
21	Rubber-tyred roller only	89	29
14	Steel-tyred roller only	25	15
35	Both types in combination	107	39
70		221	83

TABLE 5

Type of traffic control exercised

Number of sites	Type of control	Windscreen breakages (No.)	
		1st week	next 3 weeks
39	Flagmen – road closed whilst working	111	49
3	Slow-moving traffic	14	4
28	None	96	30
70		221	83

TABLE 6

Method of removal of loose chippings

Number of sites	Sweeping method	Windscreen breakages (No.)	
		1st week	next 3 weeks
11	Suction – immediately after rolling	27	6
22	Suction – later in day after completion of work	60	32
31	Suction – after completion and again later	121	41
6	None	13	4
70		221	83

TABLE 7

Incidence of windscreen breakage with 10 mm and 12.7 mm chippings

Number of sites	Nominal size of chippings	Windscreen breakages (No.)	
		1st week	next 3 weeks
36	12.7 mm ($\frac{1}{2}$ in)	114	37
34	10 mm ($\frac{3}{8}$ in)	107	46
70		221	83

TABLE 8

The use of lightly-coated chippings.

Number of sites	Nominal size and treatment of chippings	Windscreen breakages (No.)	
		1st week	next 3 weeks
33	12.7 mm – lightly coated	100	27
3	12.7 mm – uncoated	14	10
27	10 mm – lightly coated	94	45
7	10 mm – uncoated	13	1
70		221	83

TABLE 9

Binder types and viscosities

Type of binder	Nominal viscosity	Number of sites	Windscreen breakages (No.)		Month in which used						
			1st week	next 3 weeks	April	May	June	July	Aug.	Sept.	Oct.
Cut-back bitumen	100 sec at 40°C	18	52	24	2	5	1	3	4	3	—
	200 sec at 40°C	12	61	24	1	3	2	1	3	2	—
	Not known	2	0	0	—	—	1	—	—	—	1
Tar-bitumen blend	44/46° evt	15	43	9	1	8	5	—	1	—	—
	48/52° evt	11	47	19	—	—	6	2	3	—	—
	Not known	1	0	0	—	—	1	—	—	—	—
Road tar		5	5	1	—	—	—	2	2	1	—
PVC-tar		3	6	4	—	2	—	1	—	—	—
Bitumen road emulsion		3	7	2	—	1	—	2	—	—	—
		70	221	83							

TABLE 10

The effect of site length on rate of windscreen breakage:
breakages per 100,000 vehicle-kilometres

Details of site			Windscreen breakages (No.)								
	No. of sites	Total vehicle kilometres per day	In first month			In first week			In next 3 weeks		
			Forecast * (A)	Actual count (B)	Ratio B/A	Forecast * (A)	Actual count (B)	Ratio B/A	Forecast * (A)	Actual count (B)	Ratio B/A
Long sites (3 km or more)	10	240 000	72	86	1.18	17	61	3.58	55	25	0.45
Short sites (less than 3 km)	60	793 000	238	218	0.91	55	160	2.9	183	58	0.36
All sites	70	1034 000	310	304	0.98	72	221	3.1	238	83	0.35
Control lengths (less than 3 km)	57	683 000	205	68	0.33	—	—	—	—	—	—

* Vehicle kilometres per day x number of days

100 000

TABLE 11

Months when surface-dressings were applied

Month of year	Number of sites	Percentage of total	Windscreen breakages (No.)	
			In first week	In next 3 weeks
April	4	5.7	8	4
May	18	25.7	60	15
June	17	24.3	37	13
July	11	15.7	42	29
August	13	18.6	61	19
September	6	8.6	13	2
October	1	1.4	0	1
Totals	70	100	221	83

8. APPENDIX 1

LETTER INVITING PARTICIPATION IN THE SURVEY

Please address any reply to
DIRECTOR OF ROAD RESEARCH
Please quote: ZA/MC 260/272/01
Your reference:

Road Research Laboratory
Ministry of Transport
CROWTHORNE, Berks
RG11 6AU
Crowthorne 3131, Telex 84272

Dear Mr.

22 October 1970

SURFACE-DRESSING

With the use of surface-dressing on roads carrying fast-moving and heavy traffic there is increasing concern over the problem of broken windscreens. We all know that surface-dressing can be a reliable process and that it offers immense advantages in cost, improvement in resistance to skidding and general protection of the road structure. It would be a great misfortune if the process fell into disrepute because of public pressures.

Is the rate at which windscreens are broken abnormally high on newly laid dressings, or does the reputation they have acquired derive from trouble on a few projects where things go wrong? Do the breakages occur immediately after the work is done, during the summer heat waves, or later in the winter months?

The whole subject is a matter of opinion rather than fact and we want to find out as much as we can about the performance of surface-dressings on high-speed roads in the first year of their lives with the object of ascertaining the true extent of windscreen damage. At the same time we want to study how this is associated with the techniques of surface dressing that are employed.

To do this I am hoping to enlist the aid of you and some of your County Surveyor colleagues. Our thought is to follow the performance of about a hundred miles of surface-dressings on busy roads through the first year of their lives, obtaining records of windscreen breakages and other damage to motor vehicles together with information on the techniques of dressing employed and the performance of the surfacing. We have in mind to seek the co-operation of a dozen County Surveyors, each to provide records of about ten miles of surface-dressing on heavily trafficked roads, preferably on one route through the County. Our aim would be to do this exercise during the 1971 surface-dressing season, that is, starting in April 1971 and finishing a year later.

It will, I imagine, not be difficult to collect the information on the specifications for the dressings, on how the work is done, and on performance. The difficulty will be in obtaining records of the broken windscreens at regular intervals throughout the period. It might well be possible to bring this down to a rapid count of the evidence left at the side of the road, once a week for the initial period and once a month thereafter and we have wondered whether staff in the Divisions of the County could help in this.

I should be most interested in any comments you may have on this proposal. If you are interested, would you be prepared to send someone to a meeting here to discuss the project and to decide what reasonably can be done?

Yours sincerely,

R. S. Millard
Deputy Director of Road Research

9.APPENDIX 2
Questionnaire and Report Forms used in the Survey

Form MSD.1

ROAD RESEARCH LABORATORY
JOINT SURFACE DRESSING INVESTIGATION
Information to be recorded during trials to determine the extent of
windscreen damage in surface dressing
-----County Council

1. Site details

Road number	
Location	
Map reference	
Length (km)	
Description of road (Single or dual carriageway etc.)	
Traffic (Vehicle/day in both directions)	

2. Date of work

3. Method of carrying out work
(Contract, direct labour, contract spraying only etc.)

4. Existing surface

Type (Macadam, asphalt etc)			
Condition	Hard	Normal	Soft
	Porous	Non - porous	

5. Specification

Binder type			
Binder viscosity			
Rate of application (l/m ²)			
Type of additive (if used)			
Chippings	Type and source		
	Nominal size		
Condition of chippings	Coated	Uncoated	Remarks.
Method of application of chippings (Hornsey gritter- metering etc.)			
Number and type of roller	Pneumatic	Steel	Both None

6.

Weather conditions	At time of spraying
	During next 24 hours

7. After care

Method of removal of surplus chippings	
Time of removal	
Was further sweeping carried out - if so,when?	
Was traffic control imposed?	If so - how and for what period?

8. Condition of dressing 1 week after laying

If failed - give reason
(Rain, fattening up etc)

Date.

Signature of
reporting officer

APPENDIX 2 (Continued)
ROAD RESEARCH LABORATORY
JOINT SURFACE DRESSING INVESTIGATION
Counts of numbers of windscreens broken on trial lengths

Form M.S.D.2

-----County Council

1. Site details

(a) Road number:-

(b) Location:-

(c) Map reference:-

Surfaced dressed
lengths

2. Date on which resurfacing was carried out:-

3. Count of numbers of broken windscreens (Please report early failure of the dressing at (4) below)

(a) Weekly counts for first 4 weeks

1 st. week after completion

2 nd. week " "

3rd. week " "

4th. week " "

Total after 1 month

--

(b) Monthly counts thereafter to 31st December 1971

2 nd. month after completion

3rd. month " "

4th. month " "

5th. month " "

6th. month " "

7th. month " "

8th. month " "

--

Grand total to end of year (1971)

--

4. Any special remarks

Date.

Signature of
reporting officer

APPENDIX 2 (Continued)

ROAD RESEARCH LABORATORY

JOINT SURFACE DRESSING INVESTIGATION

Counts of numbers of windscreens broken on CONTROL lengths

-----County Council

Form MSD 3

1. Site details

- (a) Road number :-
- (b) Location :-
- (c) Map reference :-

Control lengths

2. Count of numbers of broken windscreen

Monthly counts on control sections

1st. month	
2nd month	
3rd month	
4th month	
5th month	
6th month	
7th month	
8th. month	

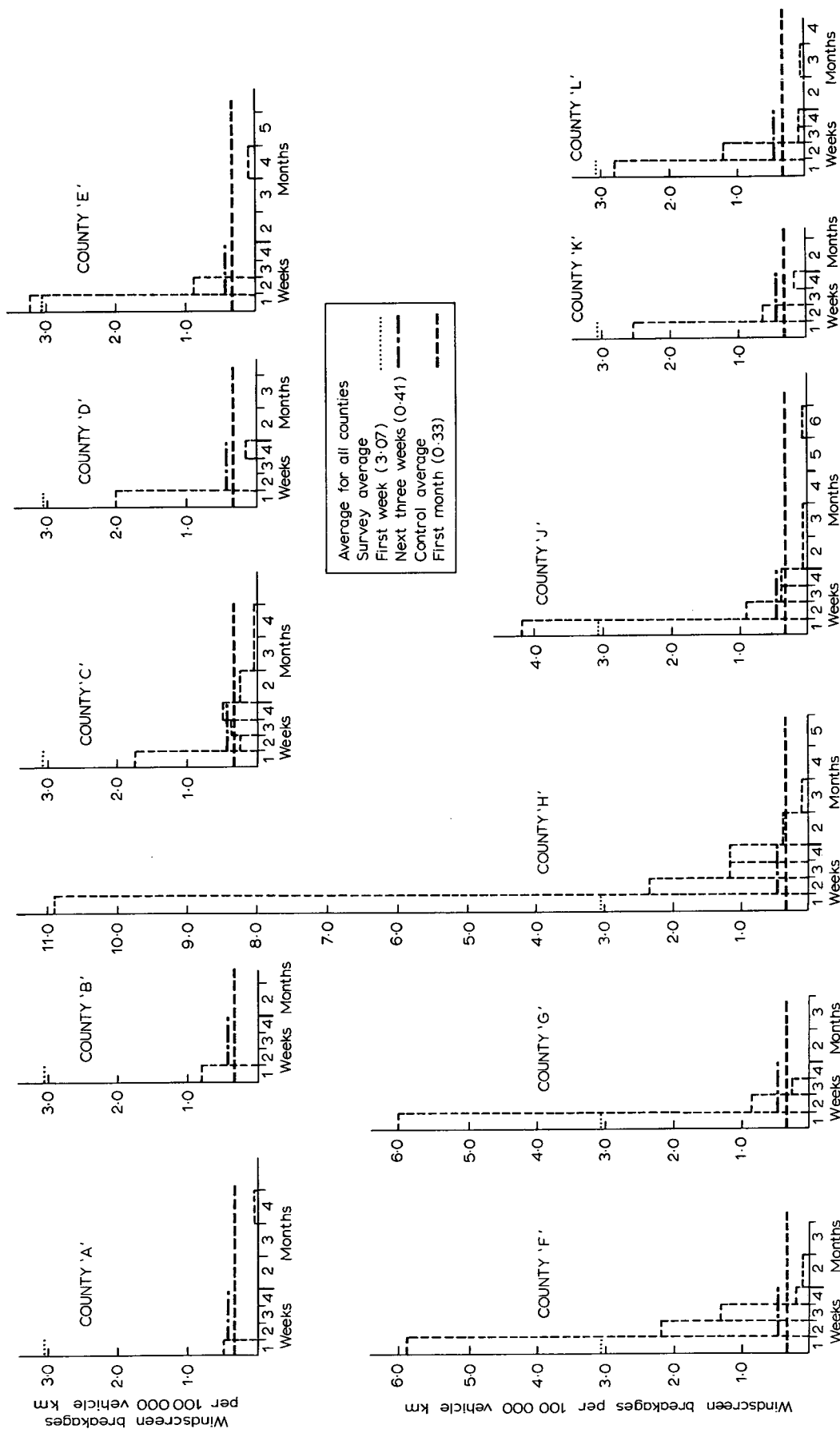
Total to end of
year (1971)

--

3. Any special remarks

Date.

Signature of
reporting officer



Time elapsed since surface dressings were applied

Fig.1 WINDSCREEN BREAKAGES REPORTED BY INDIVIDUAL COUNTY AUTHORITIES

ABSTRACT

Surface dressing: a survey of windscreen damage: N. WRIGHT, Department of the Environment, TRRL Report LR 614: Crowthorne, 1973 (Transport and Road Research Laboratory). Questionnaires about the rate of windscreen breakage on new surface dressings on heavily trafficked roads (mostly rural) were sent in March 1971 to selected County authorities. An analysis of data received from eleven counties shows the extent of the problem.

The greatest number of breakages occurred in the first week after laying the dressings and the total was independent of the size of the chipping used within the range 10 mm to 12.7 mm. Approximately three windscreens were broken for every 100,000 vehicle kilometres during this first week. In the next three week period the rate of breakage was 0.41 and thereafter was little different on the sections which had been dressed from that on untreated roads (some 0.33 breakages for 100,000 vehicle kilometres). Significantly higher rates of breakage were found on surface dressed sites longer than 3 km than on shorter sites.

No conclusive evidence was found to suggest improved performance with either lightly coated or uncoated chippings. Contrary to expectations, lower levels of windscreen breakage were found on sites where steel-tired rollers were used in preference to rubber-tired rollers. The effect of using steel-tired rollers on surface texture depth (an important factor in maintaining resistance to skidding at high speeds) requires further investigation.

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