The effect of de-icers on skid resistance and skidding accidents

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ABSTRACT

The Highways Agency, in common with all UK highway authorities, has a duty to keep roads for which it is responsible free of ice and snow. The Agency's engineers therefore carefully monitor weather forecasts and treat the roads with de-icing salt to both prevent ice forming and help remove ice or snow when they are present.

Apart from saving lives and injuries, using de-icers costs the country much less than it would if the ice was just ignored and accidents (and the congestion that results) were allowed to happen. Even though surfaces treated with salt are unlikely to be as slippery as an icy surface, some road users are concerned that de-icers can build up on road surfaces and might increase the risk of skidding accidents. To gain a better understanding of what these risks actually are, Highways Agency commissioned the Transport Research Laboratory (TRL) to investigate the effect of de-icing operations on skid resistance and skidding accidents.

The study had two phases. In the first phase, direct measurements of skid resistance were made in winter conditions on two types of road surfacing treated with different types of de-icer, including two with additives, in order to assess the physical effects. This included using Highways Agency's Pavement Friction Tester to assess the effects at different speeds from 20 to 100 km/h in selected locations and a GripTester operated at 50 km/h to make a continuous assessment of the road. The measurements covered a range of conditions, including wet or dry surfaces and different residual salt levels. However, it was not possible to test the effect of a build-up of de-icer and detritus during prolonged cold spells with little or no rainfall.

In the second phase, accident statistics in the Stats19 database recorded for the trunk road network during the period 2003-2005 were analysed to assess whether there was any evidence to indicate that accident risks increased when roads had been salted. This assessment included the potential influence of repeated de-icing operations, relative risks at junctions and for vulnerable road users such as motorcyclists. The study was supported by seeking the views of maintaining agents to identify any anecdotal trends that might not be reflected in the injury accident statistics.

This paper summarises the study, the two phases of which have been reported fully in TRL reports PPR 219 and PPR220.

1. INTRODUCTION AND BACKGROUND

UK highway authorities have a duty to keep highways free of ice and snow and endeavour to meet this duty through winter service operations. A layer of ice only about 50 µm thick can make a road potentially very dangerous. Apart from saving lives and injuries, using de-icers costs the country much less than it would if ice was ignored and accidents (and the congestion that results) were allowed to happen.

In the UK, de-icers (normally based on sodium chloride typically spread at rates of 10 and 20 g/m^2) are used to lower the freezing point of water so the road surface stays wet rather than icy. De-icers also prevent layers of ice, such as compacted snow, from bonding to the road surface so they will be more readily broken up and dispersed by traffic. Once on the road (Figure 1), the salt grains must go into solution to be effective. This happens naturally, either because the road is already wet or damp or because the salt draws moisture from the atmosphere. Passing traffic helps the process, crushing the salt crystals into finer particles which then dissolve more rapidly. If it rains or snows, the salt solution is quickly washed away. Even if there is no rain, passing traffic eventually disperses the salt so repeated treatments are required during bad weather or in longer cold spells.

Figure 1 A salt spreader

Winter maintenance practitioners are constantly seeking ways to improve their operations so that the potential for de-icers to damage vehicles, the environment and infrastructure is lessened. One way is to pre-wet dry salt with brine as it leaves the spreader; another is to treat dry salt with additives based on agricultural by-products (ABPs). These techniques are designed to improve salt distribution and retention on the road so less needs to be spread.

Even though surfaces treated with salt are unlikely to be as slippery as an icy surface, concerns have been expressed by some road users that de-icing operations, particularly repeated operations when de-icers can build up on road surfaces, can adversely affect the skid resistance and increase the risk of skidding accidents.

There are a number of ways that de-icers might adversely affect skid resistance in theory. For example:

- Although unlikely, the salt solution itself might make a road more slippery than a plain wet one, perhaps when greater salt concentrations are used or salt builds up after repeat treatments without rain to wash it away.
- Moisture is drawn from the atmosphere as de-icers go into solution: this makes the road damp or wet and keeps it that way for longer. So, when there is salt on

the road, there may be places with the lower grip of a wet surface (even though conditions are generally dry) and drivers may not notice them, especially at night.

- In long hot dry spells in the summer, dust and oil and detritus build up on the road surface and some roads can be unusually slippery when it first rains after such a period. A similar effect could occur in cold weather if, especially after repeated salting, a build-up of impurities were to make the surface more slippery:
    - Because the road is damp for longer, the moisture may loosen detritus already on it and there is more chance for dust or other detritus to stick to the surface.
    - Some de-icers naturally contain very small amounts of impurities such as marl (fine clay) or have additives based on ABPs. These do not all dissolve in water and some could be left on the surface after the salt solution has been washed off by rain or dispersed by traffic.
- When salt solution on a road surface dries, the salt will leave a bloom on the surface as it re-crystallises. This might fill the microtexture of the surface and make it seem more polished, especially on older, more heavily trafficked roads which have already been polished by traffic.

During the winter, skid resistance is usually slightly higher than in summer as the roads tend to be less ‘polished’. This is an advantage, at a time of year when roads are wet more often or for longer. However, de-icers would need to be used more carefully if their presence on road surfaces made skid resistance significantly worse than it would be on a normal wet road.

To help assess the relative risks, in December 2006 Highways Agency commissioned TRL to make an initial investigation of the effect of de-icing operations on skid resistance. The work was to be done during the winter of 2006/2007 but it was recognised at the outset that the project would not be able to cover all aspects of this complex topic in the short timescale and it would also be limited by whatever weather conditions would prevail. The work therefore was planned to assess the scope of the problem in two phases.

- The first phase would assess by direct measurements how different de-icing treatments affect skid resistance on the two main types of surfacing on trunk roads and motorways. For this, skid resistance was measured after de-icers had been spread in a series of road trials.
- The second phase had the broad objectives of determining whether there is any direct evidence for problems on trunk roads and motorways related to a reduction in skid resistance due to repeated de-icing operations and what factors might be involved. There were two strands to this part of the work:
    - An analysis of accident records to compare accident numbers in the winter with other times of year, and how accident numbers in the winter are affected by salt on the road.
    - Consultation with winter maintenance practitioners to discover whether they had any experience of possible problems in this situation, in order to ascertain whether there were any common patterns.

The study has been reported fully in TRL reports PPR 219 and PPR220. This paper provides a summary of the work and the key findings.

2. ROAD TRIALS

2.1 MEASUREMENT METHODS

Two devices were used to measure skid resistance: the Pavement Friction Tester (PFT) and a GripTester.

2.1.1 The PFT

The Pavement Friction Tester (PFT) is owned by Highways Agency and operated on their behalf by TRL. The equipment comprises a trailer with a smooth test wheel towed by an adapted pick-up truck (Figure 2). The truck carries control and recording equipment and a water tank.

Figure 2 The pavement friction tester

The brake on the test wheel can be applied independently so that the wheel locks. The tyre skids for a short time as it is pulled along the road. The machine measures and records the vehicle speed and the test wheel speed, together with the load and drag forces on the tyre, 100 times a second throughout the five-second brake-and-release cycle from which the friction between the tyre and the road can be calculated.

The PFT can measure locked-wheel friction at different speeds. It can wet the road just in front of the test wheel, which is the usual way of measuring skid resistance or, with its water pumps turned off, it can measure the road surface as it is. Routinely, skid resistance is measured with devices such as SCRIM (Sideway-force Coefficient Routine Investigation Machine) that measure skid resistance at low speeds. However, on wet surfaces, skid resistance decreases markedly with increasing speed and the purpose of using the PFT in this work was to assess whether any effects associated with the application of salt were different at different speeds.

2.1.2 The GripTester

The GripTester (Figure 3) is a small three-wheel trailer towed behind a van which houses the control computer and a water tank.

Figure 3 The GripTester

The smooth test wheel (the one on the left underneath the unit in Figure 3) is linked to the main axle by a gear and chain arrangement that forces the test wheel to rotate more slowly than the drive wheels. This means that the test wheel slips over the road surface as it is towed along. The contact patch on the test tyre slips over the road at a low speed compared with the speed of the test vehicle. For example, at a test speed of 50 km/h, the test wheel slips over the road at about 7 km/h. In normal use, the GripTester wets the road in front of the test wheel to measure skid resistance but, as with the PFT, the water can be turned off to measure the road as it is.

Unlike the PFT, which makes its measurements over discreet lengths of road while the wheel is momentarily locked, the GripTester makes a continuous measurement of skid resistance, recording values every ten metres. It was used in this study to check how the skid resistance varied along each trial site and to assist the interpretation of the PFT measurements. Whether GripTester could be used on a routine basis to measure the effects of de-icers following normal treatments was also investigated.

2.1.3 General approach to the measurements

The general approach to the road trials was to make measurements of skid resistance on an in-service road in winter conditions after salt had been applied and at various times after the application to assess the effects of traffic, weather and in some cases repeat applications.

Both devices were used with their on-board water supply turned on (so-called “wet” tests) to measure the background condition of each trial site without salt to provide a benchmark against which the effects of the salt could be compared. They were used in “dry” mode to measure the condition of each site after salt had been applied, without adding water that might wash the salt away.

For each surface condition being measured, the PFT tests measured the skid resistance on each surface at four different speeds. It was assumed that the surfaces were generally homogenous and a sequence of replicate tests was made at each speed, starting at the slowest speed, accelerating to the next speed and so on during a single pass of the test site. For each test condition, four measurements were made at 20 km/h, three at 50 km/h, two at 80 km/h and one at either 90 or 100 km/h (depending on whether the road was a single- or dual-carriageway) so that a representative distance along the road was sampled in each case

During the tests on the de-icers, the GripTester ran ahead of the PFT, measuring skid resistance in the offside wheel path (so that it did not affect measurements by the PFT in the nearside wheel path). As an extra check, the background condition in both wheel paths was measured to make sure that they were similar (which is normally the case).

2.1.4 Sites and treatments

The road trials were conducted on sections of the A69 in Northumberland and the A421 near Bedford where different de-icers were normally used. There were pairs of sites within each section representing two types of road surfacing with different characteristics, namely, positively textured hot-rolled asphalt and negatively textured thin surfacing.

Four different types of de-icer were tested, one on each pair of sites. These were: dry rock salt; two rock salts treated with additives based on ABPs and pre-wetted rock salt (dry rock salt and brine in proportion 70:30 by weight).

The testing was done over a three week period in January and early February 2007, mostly overnight. Preliminary tests to establish the best methodology were made on the A69 in the first week. During the second week, more measurements were made on the A69 with increasing de-icer spread rates. The third week saw a similar pattern of tests on the A421 sites, plus a special set of tests with very high spread rates.

2.2 SUMMARY OF RESULTS

2.2.1 Typical PFT measurements

Figure 4 is a typical example of the PFT measurements which shows how the friction varied with the test speed on one site on the A69. Each point on the graph represents the average friction measured in one second in an individual skid while the test wheel was locked. The results from the wet tests, recording the background condition of the road with no salt present, are in blue. The results in green show the friction from a "dry" test when there was salt on the road and the road was damp. For this example, it was estimated that the amount of salt on the road (remaining from a series of five separate treatments over the previous 36 hours) was in the range 50 to 55 g/m^2.

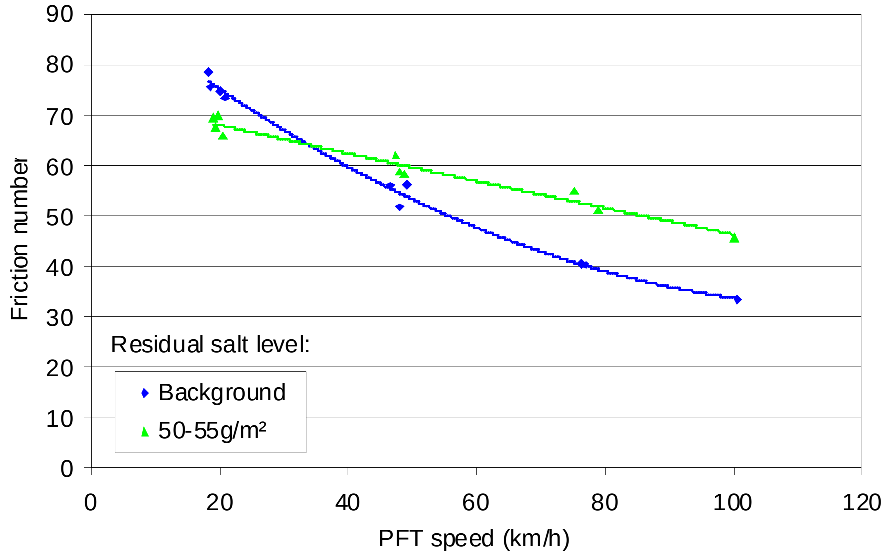

Figure 4 Typical variation in friction number with speed

The two curves show how skid resistance decreases as speed increases. The decrease in the background skid resistance with increasing speed is typical of road surfacings in good condition. The skid resistance also decreased with increasing speed when salt was on the road. Compared to the background condition, the damp salted road had lower skid resistance at low sliding speeds and higher skid resistance at higher sliding speeds. Although the actual friction numbers varied, similar effects were found on both types of surfacing for most salting conditions.

2.2.2 Typical GripTester measurements

The GripTester measured the average skid resistance along every 10m of each trial site. Figure 5 shows the measurements for the same site and conditions as for the PFT in Figure 4.

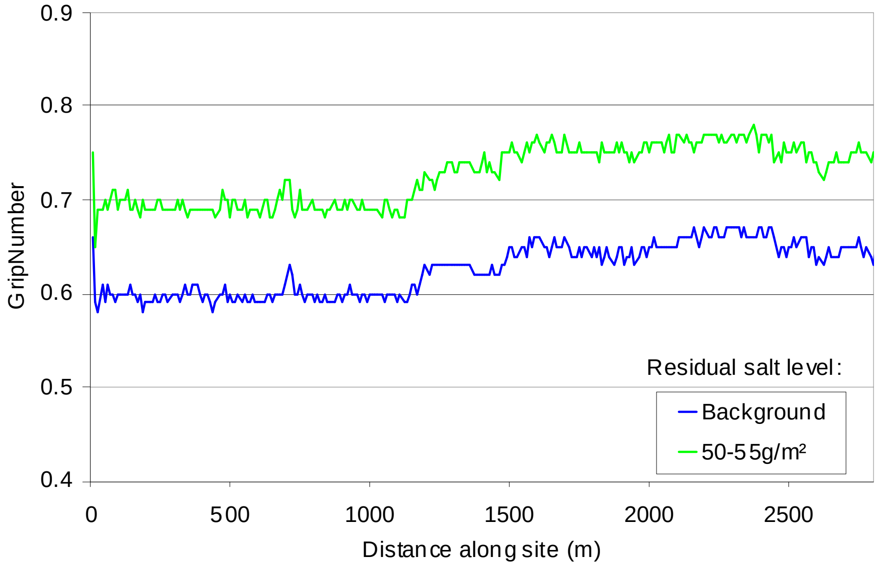

Figure 5 Example of variation in GripNumber along a site

The background skid resistance was reasonably constant over the first 1000m but it increased by about 10% over the next 500m, and then remained fairly constant over the last 1000m. The skid resistance measured when salt was on the road changed in the same way as the background level, but the skid resistance was higher on the damp road with salt than on the wet road without salt.

In this example, the PFT measurements at 20 and 50 km/h were in the first 1000 m of the site and the 80 and 100 km/h tests were in the last 1200 m. Therefore, Figure 4 includes small variations in the background condition along the trial site as well as the changes due to the speed. However, this does not change the general picture.

2.2.3 Comparison of PFT and GripTester

The measurements for all eight trial sites (i.e. for all four salts on both types of surfacing), showed similar trends. However, at first sight, it seemed as though there was a contradiction between the GripTester (which showed an increase in skid resistance with salt on the road at its low sliding speed) and the PFT (which showed a decrease at 20 km/h).

The two devices use different measuring principles, so exactly the same results were not expected. However, to investigate the apparent contradiction, detailed data from individual PFT skids were analysed to estimate friction when the PFT test tyre was slipping over the road surface in conditions similar to those of the GripTester tyre.

It was found that in very low speed conditions the PFT also measured more friction when salt was present compared with the background level. This gave confidence in the GripTester measurements, and it was concluded that the device is not suitable for general use in detecting any adverse effects due to salt because it cannot measure how friction varies with speed.

2.2.4 The effects of salt level, salt type and surfacing

The PFT data from 48 tests were analysed to compare the skid resistance when salt was on the road (and the road was wet or damp) with the background wet level. The salt levels in the different tests ranged from 10 g/m^2 up to 190 g/m^2. During most of the tests the level was very much more than would result from normal operations.

- For some of the tests, the residual salt level was deliberately built up. By spreading it at 30 g/m^2 six times over a period of nine hours, it reached a level 190 g/m^2 in one sequence of tests. It was found that with salt on the road, friction at 20 km/h decreased by 13% on average, ranging from 2% to 23%.
- On two sites, 190 g/m^2 of salt was spread as a single treatment over a short length of road. The friction was measured as soon as possible before the salt had dissolved, and again up to 3½ hours after spreading. In this special case the maximum decrease in friction at 20 km/h relative to the background level was 18%, within the range of all the other tests.
- No significant differences were detected between the four salts used in the tests in the effects they measured. This included those with additives. Neither was there a marked difference in behaviour between the two types of surfacing.

2.3 OVERALL FINDINGS FROM THE ROAD TRIALS

A skid will not start unless the demand for friction between a tyre and the road is greater than the maximum the road can provide. The maximum friction occurs when the tyre is just beginning to slip over the surface that is to say, at a very low slip speed.

- It was found that skid resistance at very low speeds on damp or wet surfaces with salt is higher than on wet unsalted roads. This suggests that a tyre is no more likely to start to skid on a salted road than it is on a wet road.

A small decrease in skid resistance was measured at low sliding speeds (20 - 40 km/h). This implies that, once a wheel has started to slip, at these speeds there might be an increased risk of skidding on a salted road compared with an unsalted wet one. This would only be important if the risk was greater than on wet roads, so it is concluded that:

- Where skid resistance is already well above the investigatory level, as it was for the trial sites, de-icers are unlikely to increase the risk of skidding. (The Investigatory level represents a limit above which the skid resistance is assumed to be satisfactory but at or below which the road is subject to a more detailed investigation).
- On roads where the background skid resistance is closer to the investigatory level, or in years when there is little or no seasonal increase from summer to winter, de-icers may reduce skid resistance below the summer minimum and the investigatory level.
    - o Therefore, there is a small theoretical increased risk of skidding in these specific circumstances.
- At higher speeds, the PFT measurements showed greater skid resistance on the damp or wet salted roads so it is unlikely that salting poses any greater skidding risk at high speeds than would already exist when the road is wet.

The effects of very large applications of salt were assessed over a short time, but because the winter of 2006/2007 was unusually mild it was not possible to look at the effect of prolonged periods of salting with little or no rain. These are the conditions when salt and detritus might build up on the road surface and affect friction more than was measured in the tests. However, the significance of such conditions was investigated in a study of accident statistics.

3. ACCIDENT STUDY

3.1 METHODOLOGY

The accident study analysed the national accident statistics (Stats19) and Highways Agency databases of traffic flows and winter maintenance records in three stages:

- For the first stage, accident records for the three-year period from 2003 to 2005 on the truck road network (the most recent available) were used to provide an overview of winter accidents in comparison with other times of year. This included analysis of the road surface condition (whether it was dry, wet, or there was ice or snow present), road class, junction type, weather condition, the types of vehicles involved, skidding and analysis of contributory factors.
- For the second stage the database that reports winter service operations was used in combination with the accident data. Accident densities – the number of accidents per 100 km per year – and characteristics of winter accidents were determined for Highways Agency's different maintenance areas on days when de-icers were used and days when they were not. The effect of de-icing over a prolonged period was assessed for one maintenance area.
- In the third stage, the accident rate – accidents per 100 million vehicle kilometres (veh-km) – was calculated from accident numbers and traffic levels. The analysis concentrated on specific routes for which both traffic data and salting records were available. The total accident rates on days when the roads had been salted over a long period and days when they had not were compared.

3.2 SUMMARY OF RESULTS OF ACCIDENT ANALYSIS

3.2.1 National overview

There are about 6,800 km of trunk road in England. Although these routes represent only 2.3% of the total length of the UK road network, they carry 130 billion veh-km, 30% of all traffic in England, and account for 8.5% of injury accidents in England. The trunk road network is high standard and has an average accident rate of 11.5 accidents per 100 million veh-km compared with an average of 41 accidents per 100 million veh-km for all roads in England.

In the first stage of the analysis, the overall numbers of accidents on the trunk road network were analysed to see how the numbers in winter compared with those in summer. Accidents were allocated into categories that included the quarter of the year in which the accident occurred and other factors and then the accident severity, numbers of skidding accidents and surface condition was considered for each of these, as illustrated in Figure 6.

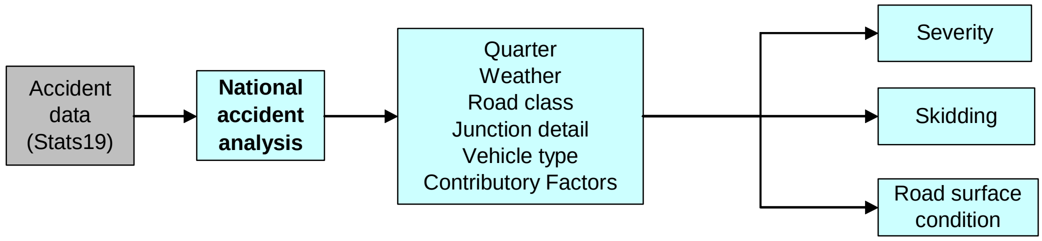

Figure 6 Accident data analysed

Table 1 shows the numbers and severity of accidents that occurred in each quarter of the year for the years 2003 to 2005. Quarter one and quarter four are the winter quarters when frosty conditions occur and de-icers are used. The table also shows the percentage of accidents that involved skidding. Those are the accidents in which at least one vehicle in the accident was reported as having skidded, jack-knifed or overturned. The last column of the table shows the "severity ratio", which is the percentage of accidents which resulted in fatal or serious injuries, and gives an indication of the relative severity of the accidents in each quarter.

Table 1 Accidents by severity and skid accidents by quarter

Quarter	All accidents				% of accidents involving skidding	Severity ratio
	Fatal	Serious	Slight	Total		
Jan – Mar (Q1)	241	1,259	9,068	10,568	43%	14%
Apr – Jun (Q2)	273	1,365	9,415	11,053	44%	15%
Jul – Sep (Q3)	278	1,542	10,481	12,301	44%	15%
Oct – Dec (Q4)	277	1,339	11,072	12,688	44%	13%
Total	1,069	5,505	40,036	46,610	44%	14%

The general analysis shows that there was no great difference between winter and summer in the overall number of accidents and that about half the accidents over the three years happened in the winter. The number of accidents was greatest in Q4 but this does not mean there was an increased risk, as no account is taken here of traffic patterns throughout the year. 14% of accidents were fatal or serious and this figure was slightly lower in Q4. The proportion of accidents involving skidding was the same throughout the year at about 44% per quarter.

Figure 7 compares the severity of skidding accidents with non-skid accidents. It shows that skidding accidents were always more severe than other accidents and were slightly less severe in winter (Q1 and Q4) than in the summer months.

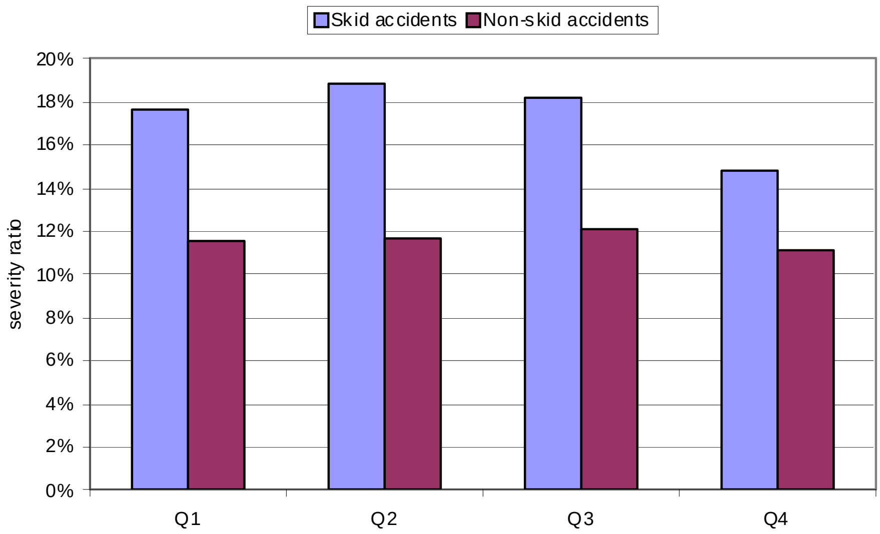

Figure 7 Severity ratio of skid and non-skid accidents by quarter

When accidents were analysed by road surface condition (those occurring on dry, wet or icy roads), it was found that most accidents happened on dry roads but in winter the proportion on wet or damp roads was roughly double that in the summer. Only a small proportion of accidents was recorded as happening on road surfaces with ice or snow and, not surprisingly, all occurred in the winter (5% in Q1 and 2% in Q4).

- The proportion of skidding accidents both on dry and wet or damp surfaces was lower in the winter (when roads are salted) than in the summer.
- As expected, a high proportion of the accidents on ice, frost or snow involved skidding.
- Accidents were more severe on dry roads in the winter than in the summer, whereas the opposite was the case on wet roads, but the differences were small.

The national analysis also showed that about a quarter of skidding accidents involved cars, taxis and minibuses and the proportion was the same in the summer and winter. The proportion of skidding accidents involving powered two wheelers (motor cycles) was also the same in summer and winter but the percentage was higher at 31%. A slightly smaller proportion of skidding accidents near junctions occurred in the winter (29%) than in the summer (31%).

Overall, no evidence was found in the national accident analysis of an increased risk of accidents in the winter when de-icers are used. In particular, there was no indication of increased risks at junctions or for motorcycles.

3.2.2 Accidents on roads with and without salting

Having reviewed general levels of accidents on the network, accidents on days when roads were salted and days when they were not were analysed. Because accident numbers on any particular road are usually small, the data for a number of routes were combined to make sure that they represented similar conditions.

Accidents in maintenance areas where salt was applied at the same rate on all routes in the area and the days when this had happened were analysed. The number and severity of accidents, the percentage of accidents involving skidding and the accident density (number of accidents per 100 km per year) for the days without salt and the days with salt were then compared.

Table 2 summarises the results of this analysis.

- The severity ratio and proportion of skidding accidents with and without salting were very similar.
- The accident density was slightly higher for the days with salting. However, the 95% confidence intervals show that the difference in the accident density on days with and without salting is not statistically significant.
- When data for Highways Agency's 23 maintenance areas were analysed separately, none of the areas showed large differences between the accident densities with and without salting.

For one area, the accidents occurring when roads had been salted over a number of consecutive days were examined. Some small differences in the accident characteristics and the accident density were found, but the number of accidents involved was too small for any differences to be statistically significant.

3.2.3 Accident rates with and without salting

The analysis summarised in 3.2 and 3.3 considered accident numbers and accident densities, combining data from larger areas to give an indication of any trends. However, the number of accidents on any particular road depends on the amount of traffic so the accident rate (accidents per 100 million vehicle-km) was assessed.

Routes (rather than areas) with sufficient information on traffic and salt were selected. The accident rate was calculated for the total number of days with and without salt. For some routes this included extended periods of salting. The number of accidents on individual routes tended to be small and variable so the routes were combined to give an overall accident rate, although this was still sometimes based on a small number of accidents.

Figure 8 compares the overall accident rates on the routes for different numbers of consecutive days of salting with the same routes without salting. The bars represent the 95% confidence intervals.

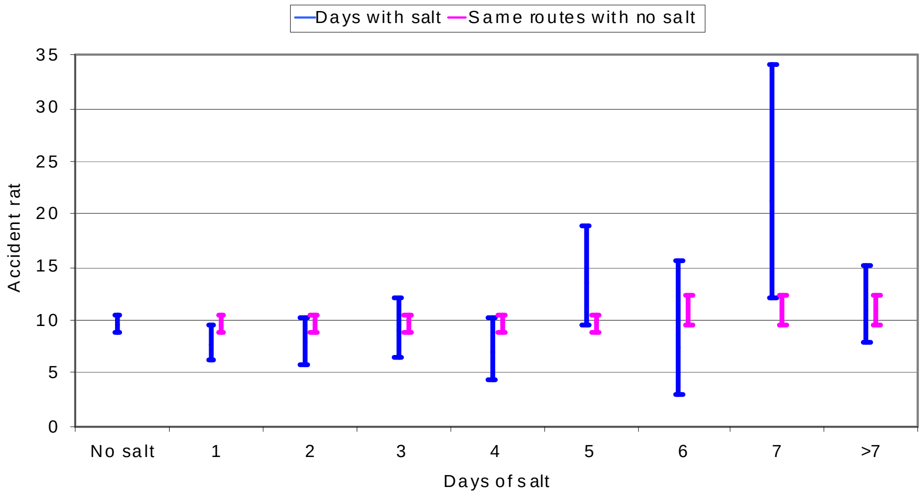

Figure 8 Accident rates by days of salt with 95% confidence intervals

The confidence intervals for the days with salt are larger than those without because the number of accidents on days with salt was much smaller than on days with no salting. The confidence intervals overlap, so there were no significant differences in accident rates on days with and without salting, even after several consecutive days.

3.2.4 Salt treated with additives based on ABPs

There have been concerns that de-icers treated with additives based on ABPs might present an increased risk of skidding. When these concerns were investigated it was found that most, if not all, of the cases reported appeared to have occurred on routes where such salts were not used.

The road trials had included ABP-treated salts and shown no differences. The accident data for one route where this type of de-icer had been used were analysed separately. The route was salted on 50 days out of the 274-day winter period analysed. The number of accidents was small and it was not possible to detect a difference in the accident rate on days with and without salting.

3.3 INFORMATION FROM WINTER MAINTENANCE PRACTIONERS

A questionnaire was sent to winter maintenance practitioners asking for their experience of accidents associated with de-icers on the roads.

None of the practitioners provided evidence of accidents that they thought could be attributed directly to the presence of de-icers. Some expressed concerns about situations that might occur that could be more risky, but there was no hard evidence.

3.4 OVERALL FINDINGS FROM ACCIDENT STUDY

The accident study has shown that, broadly, there is no evidence that accident densities and accident rates on the trunk road network are higher on days roads have been salted than on days when they have not, even after several consecutive days of salting. However, there were limitations in the available statistics and the relatively small numbers of accidents in many situations may have masked some effects. Because the analysis was based on the injury accident database, it was not possible to assess the situation in relation to damage-only or other non-injury accidents that may have occurred but were not recorded in the national statistics.

Nevertheless, the findings from the accident statistics are consistent with the findings from the road trials, that is, the effect of de-icers on accident risk was insignificant.

4. CONCLUSIONS

It is concluded that for Highway Agency’s trunk road network:

- De-icing operations will not increase the risk of skidding accidents on most, if not all, of the network. Only on roads that are close to their investigatory level is there a small theoretical increase in risk, but this is unlikely to be significant.
- In any event, skid resistance with de-icers present will always be much greater than would be the case if they were not used and frost or ice were present.
- There is no evidence from national statistics that the use of de-icers increases personal injury accidents, including those at junctions and those involving motorcycles.

- Winter maintenance practitioners that are responsible for de-icing the network provided little or no hard evidence of accidents associated with reduced skid resistance from de-icers.

However, drivers should be aware that de-icers can make roads wet, and they can remain wet for longer than they would otherwise be. Road users should drive as they would on wet roads when de-icers are present.

The road trials and accident study concentrated on trunk roads and Highways Agency's approach to de-icing. On local authority roads, road layouts and conditions, and de icing practices, are often markedly different. De-icers and detritus may build-up differently on such less heavily trafficked roads so their effects on skid resistance may be different.

During the road trials, measurements were confined to the wheel paths used by cars and larger vehicles. They did not look at other areas of the road that are sometimes used by pedal and motor cyclists and all drivers when overtaking, where the build-up of salt and underlying skid resistance patterns may be different.

Full details of the two studies summarised in this paper are available in TRL reports PPR 219 and PPR220.

5. REFERENCES

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