

# Road Accidents in the Winter Related to Climate and Maintenance Strategies

Salt has been used for decades to improve accessibility and safety on roads in the winter. There is no doubt that the salt improves the driving conditions significantly in the winter. However, the effect on safety is open for discussion and data assembled by VTI indicates that the safety effect is dependant on both the climate and the standard of the maintenance service.

Friction control of winter roads is a major task to assure safety and accessibility to the road users in cold climate. Traditionally, there are two main methods, salting and gritting, with both advantages and disadvantages. The scope of the presentation is to discuss the efficiency of the different methods on the safety and accessibility due to the climatic conditions. The present report is based on analysis of the data assembled for the VTI project "Winter Model", and presents mainly comparisons between accident data, operation standards for winter maintenance and climatic conditions in the different regions of Sweden.

## Strategies for friction control of roads

All Scandinavian countries have established guidelines for defining strategies and methods for assuring acceptable standards for the road conditions in the winter period. Generally, they are based on the traffic loads and the importance of the roads. Salt is mainly used for friction control on the most important and busy roads. None of the Scandinavian countries has defined climatic conditions to the guidelines for salting. However, there is a practice in Finland, Sweden and Norway to avoid or reduce the use of salt in the coldest areas of the countries. Salt is used to avoid the formation of compacted snow and ice on the roads and preferably salted roads should be free of snow and ice the whole winter. In practice, salt has limited effects during

snowfalls and temperatures below -8° C. The effect of the traditional gritting method is limited. The last ten years an impressive research in the Nordic countries has been carried out on developing equipment for the warm wetted sand method, which is based on mixing hot water with sand just ahead of the spreading to have the wetted sand freeze to the snow/ice surface. The improved friction and durability have shown to be significant in areas with cold, stable climates.

## Accidents versus winter maintenance standards

The basis for the data used in the present analysis is all the police recorded accidents on the state roads in Sweden and data of road surface conditions recorded by the road authorities in the 1993/94 to 96/97 winters. The accident data are broken into

- Types of accidents and severity of the accidents
- Road conditions at the time of the accidents
- Vehicle mileage on the different road conditions
- Maintenance standard for the roads.

The accident analysis include only fatalities and severe injuries and are made separately for

- Four climatic regions; southern, central, lower northern and upper northern Sweden
- Three maintenance standard classes; A1+A2 and A3+A4, which require salting, and B1+B2, which is based on gritting
- Two road conditions; bare roads and snow/ice covered roads

## Calculated accident rates

Figure 1 may be considered to be representative for the calculated accident rates for the salted roads. Generally the vehicle mileage on bare road surfaces is 75–96 per cent of the total volume and the accident rates on bare roads are much lower compared to driving on snow or ice covered surfaces. The accident rates shown in Figure 1 represent the probability for a driver to be involved in an accident in certain conditions. One should have in mind that the number of accidents on a road is the product of the accident rate and the vehicle mileage. To reduce the number of accidents one should preferably reduce both the accident rate for the different surface conditions and the ratio of the vehicle

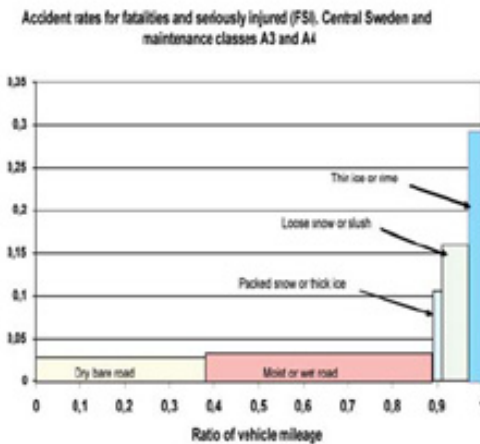


Figure 1. Representative figure for presenting ratios of vehicle mileage and the accident rates on specified road conditions. The example is for A3+A4 roads in Central Sweden.

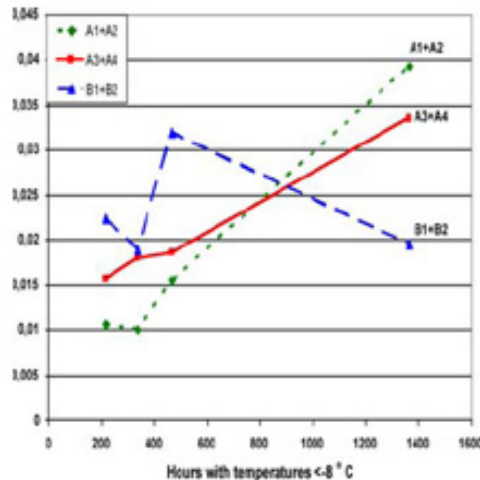


Figure 2. Number of accidents related to driving on snow and ice covered roads specified for winter maintenance standard classes, climatic regions and average hours with temperatures below -8° C for each region.

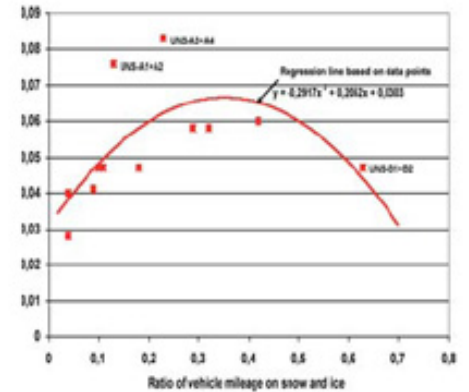


Figure 3. Regression line presenting number of fatalities and severe injuries as a function of the ratio of vehicle mileage of snow/ice covered roads. The dots represent data for different maintenance classes and climatic regions.

mileage for driving on conditions having the highest accident rates. The number of accidents related to driving on snow and ice are presented in Figure 2. For the three southern regions the salted roads have the lowest number of accidents, and there seems to be a positive effect of the higher standard classes A1 and A2. The results from upper northern Sweden are quite opposite. The number of accidents for the salted roads is almost twice as high compared to the unsalted roads. This is probably a result of the high amounts of temperatures below  $-8^{\circ}\text{C}$  found in upper northern Sweden, and at which conditions salt may be to more harm than doing nothing.

The accident rates for driving on snow/ice covered roads are dependent on the ratio of vehicle mileage. The accident ratio for snow/ice to bare roads is as high as 8–10 for vehicle ratios of approximately 5 per cent and 2–3 for ratios exceeding 50 per cent. For instance is 30–40 per cent of the accidents recorded on the A1+A2 roads in southern and central Sweden occurring on the 4 per cent of the time the roads have been covered by snow or ice.

The data material indicates that there is a maximum in accidents for vehicle ratios on snow and ice between 0.2 and 0.4 (Figure 3). If these indications are correct, one should preferably introduce salting if the ratio of snow and ice on unsalted roads are 0.3–0.5 and the use of salt may reduce the ratio to less than 0.2. On the other hand, by introducing salt in climatic areas having ratios

exceeding 0.5 and ending up with ratios close to 0.2–0.3 would probably increase the number of accidents.

The ratio of the summer/winter accident rates for fatalities and severe injuries are found to be higher for salted than for unsalted roads in all four climatic regions, 1.2 and 1.0 respectively. One should, however, have in mind that the types of roads that are salted and unsalted are quite different concerning standards and traffic loads.

The data material also makes it possible to calculate the accident rates for driving on bare roads in the winter and to compare these rates with the respective summer accident ratios. The accident rates for driving on bare roads in winter are in average 0.75 compared to summer for salted roads and 0.55 for unsalted roads. Probably drivers on unsalted roads expect the roads to be partly covered with snow or ice in the winters and they reduce the speed even when the roads are bare. Similarly, drivers on salted roads expect the roads to be free of snow and have thus a higher speed when the roads are bare.

### Conclusion

The use of salt improves the accessibility of winter roads, and the reductions of vehicle ratio for A1+A2 and A3+A4 roads on snow and ice are calculated to 60 per cent and 80 per cent relative to the respective vehicle mileage on snow and ice for roads that are not salted. The effect on safety is, however, more difficult to estimate, especially for the three southern regions. There are two

relationships that indicate that the number of accidents is lower on salted than unsalted roads. The number of accidents related to driving on snow and ice is lower for salted roads, and the number of accidents should decrease if the ratio of vehicle mileage on snow and ice is less than 0.2. On the other hand the accident rates in winter are approximately 20 per cent higher than in the summer for salted roads and equal for unsalted roads. It is thus not possible to calculate a certain improvement in safety as a result of the improved driving conditions given by the salting of roads, unless one has reliable data for comparable types of roads. For the conditions in upper northern Sweden there is no doubt that the salting of roads gives higher accident rates. The conclusion of the authors is thus that the use of salt should be used with great caution in areas with very low winter temperatures. In such climate use of pre wetted sand probably gives better safety and acceptable accessibility.

*Harald Norem, NTNU, Norway  
Staffan Möller, VTI, Sweden*

### Contact:

[Harald Norem](#)  
[Staffan Möller](#)