NEW STRATEGIES FOR WINTER MAINTENANCE IN GERMANY

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ABSTRACT

Based on practical experiences and intensive research in the last years winter maintenance strategies in Germany were developed further on.
More Preventive Spreading: In cases of hoarfrost, black ice and freezing rain it is optimal to spread preventive and avoid slippery road conditions based on optimized road weather information.
Liquid Spreading: For preventive actions in the most cases the best method is spraying of liquid brine, better than pre-wetted salt.
In Cases of snowfall are also preventive actions recommended to give a thin film of salt under the snow. During snow fall salt spreading is useful to hold the snow loose, but it needs only small amounts of salt. After snowfall it is necessary to remove as much as possible mechanically with effective snow plows. After plowing salt spreading is necessary to reach black roads.
These new strategies are implemented in new guidelines and recommendations for optimized snow removal and salt spreading in Germany.
The implementation of liquid spreading needs extra liquid spreaders or combi-spreaders which allow both liquid and pre-wetted spreading.
With this new maintenance strategy it is possible to make winter maintenance more effective and reducing salt amounts at the same time.

1. PREFACE

Salt is an essential part of an effective winter maintenance, especially on roads with strong and fast traffic. On these roads salt spreading in Germany is standard. But nevertheless it is the aim of winter maintenance to minimize the spreading amounts referring to economic and ecologic demands.

Under these conditions pre-wetted salting was developed and has become standard in Germany since many years. But still there is the question what is the right density to spread in which situation. How can it be reduced without risks for the traffic?

In Germany there has been a big development in the spreading strategy in the last years. On the basis of practical experiences in the last strong winter periods and several research projects the spreading technique was developed further and new guidelines for practical snow removal and salt spreading were established. These guidelines give advices for spreading more particularly then before.

In the following paper these new guidelines are presented and their background illuminated.

2. PREVENTIVE SALTING

In Germany the climate brings very often temperatures around 0℃ with quick changes between freezing and thawing. Freezing moisture and hoar frost are frequent surface conditions.

In Germany in the last years traffic volume is always rising, and also traffic speeds. In the same time the requirements of road users were also rising. Road users expect ice-free roads at every time during the winter period, especially on the motorways. So road users drive with high speed at every time, also when the temperature is below 0 ℃. If there is ice on the motorways it is very dangerous with a high accident risk.

The Research on Traffic Safety shows that punctual and unexpected slipperiness is the most dangerous surface condition. In these cases the accident risk is many times higher than after snowfall. Therefore these forms of slipperiness must be avoided. But this is only possible by preventive spreading just in time before the formation of ice.

In former times in Germany preventive spreading was not allowed or not welcome. The reason was that there were no sufficient weather forecasts and no good spreading methods to do the preventive spreading in a good way.

But nowadays we have a good know-how about the physical procedures when ice formats and we have improved and detailed road-weather-information and exact forecasts. On this base it is possible to determine the necessity and the right time for preventive spreading.

Such a preventive spreading just-in-time is not only good for traffic safety and traffic flow. It also leads to a saving of salt, because for prevention of ice formation is less than half of the amount of salt needed as for thawing the ice in a short time (see Figure 1).

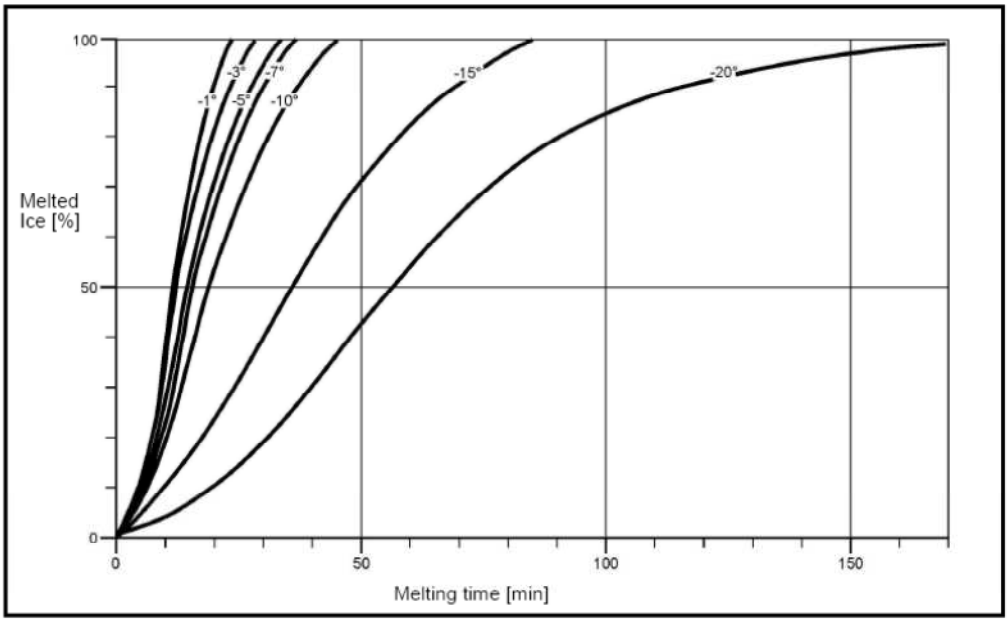

Figure 1 – Duration of the melting process when curative spreading [3]

So preventive spreading done in the right way leads to better traffic safety and traffic flow, higher economy and better environment. So it is necessary to execute this way of winter service every time when it is possible.

Preventive spreading has also another advantage compared to curative spreading: the winter maintenance truck can drive on a dry or a wet road when spreading. So it is safer for the maintenance staff and the truck can drive faster and saves time.

In Germany also jurisdiction requests preventive spreading. When there is a situation which leads to icy roads (especially freezing moisture on the road) with high probability the legal duty for spreading becomes a duty for preventive spreading.

So the new strategy is to do preventive spreading in every situation when it is possible, that means in cases of hoarfrost, black ice and freezing rain.

Naturally preventive spreading is not possible with dry salt, it needs pre-wetting. But nevertheless it is very difficult to spread the right amount of salt and to disperse it on the road in a good way, even when driving faster. So preventive spreading needs much know-how and a good technique.

3. LAYING PERFORMANCE OF THE SALT ON THE ROAD

Up to the last years there was not much knowledge about the performance of the salt on the road after the spreading. In former times this was not so important because salt was normally spread curative, which means on a snowy or icy surface, so that the salt went immediately in chemical reaction.

But with changing the strategy to more preventive actions this question becomes more important because it must be known how much of the spread salt remains on the road until the ice will format.

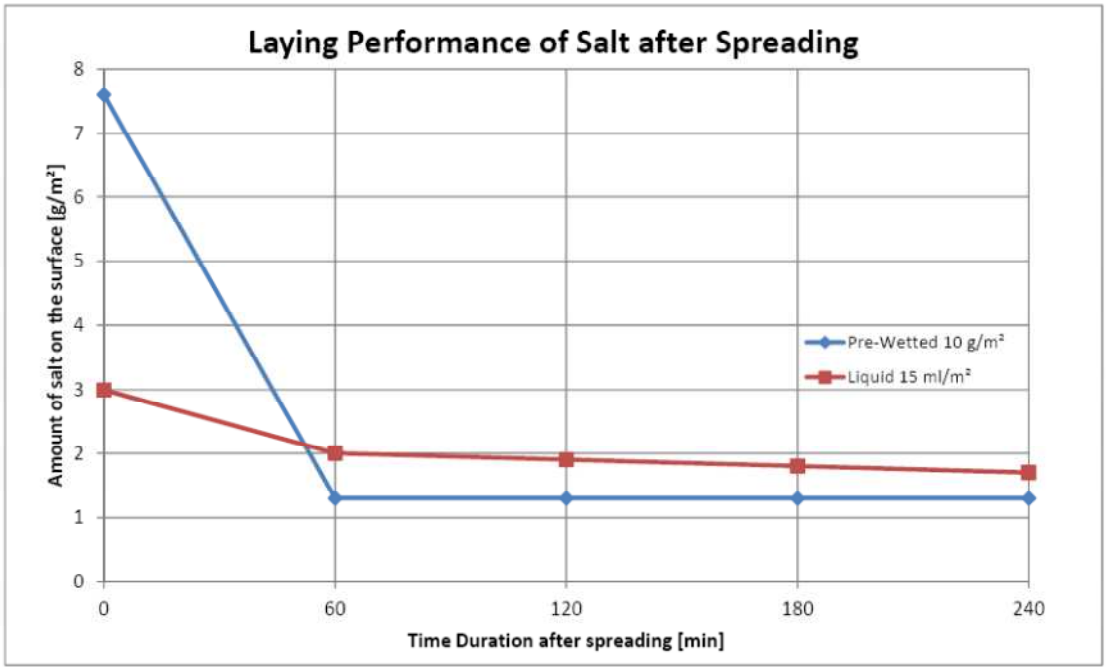

Figure 2: Comparison pre-wetted and liquid spreading [14]

Therefore different research projects in Germany were started in the last years. In this projects there was measured the amount of salt and its distribution over the spreading pattern not only directly after the spreading but also in the period after the spreading time. The first project analysed pre-wetted spreading on motorways, then followed projects

dealing with liquid spreading and the comparison of different types of spreading. New projects still running deal with spreading on rural and urban roads. [1, 13, 14, 15, 16, 17, 18]]

There are very much influences on the laying performance of salt which must be taken into account and must be determined. But the results show generally clear tendencies: Figure 2 shows the comparison between pre-wetted salt and liquid spreading. It shows that in case of pre-wetted salt there is a big loss of salt on the surface in a short time. After 60 minutes there is only 20 % left, what means less than the liquid part of the spreading. In comparison to this liquid spreading is much more durable: After 60 minutes there is about 70 % left, and that remains over a long time at this level.

This means that preventive spreading especially on dry and moistly surfaces should be done with liquid-spreading, because it needs clearly less salt (approximate one third) and stays longer on the surface. Preventive spreading with pre-wetted salt must be done with more spreading density and very close before the formation of ice (best less than 60 minutes) to loose not so much salt, but this is very difficult.

4. LIQUID SPREADING

Liquid spreading in the past was not usual in winter maintenance in Germany. Usual was mainly pre-wetted salt for all weather and pavement conditions.

But with growing need for preventive spreading on dry or moist surface and with considering the results of the research concerning laying performance of salt on the surface it became necessary to reassess the German winter maintenance practice.

In the last years there were carried out many field tests and several research projects concerning liquid spreading. They showed very good results. On dry or moist pavement the brine can be spread with good accuracy even with high speed and large spreading width and the brine remains on the surface much longer than pre-wetted or dy salt . So this is the best method for preventive spreading in the future [12, 14, 15, 16, 17, 18].

But liquid spreading is only recommended at temperatures near the freezing point, down to minimum -6℃ to avoid over-freezing of the brine on the road surface. But normally preventive spreading takes place in this temperature area. So liquid spreading should become standard for preventive spreading.

Picture 1 and 2: small and big liquid spreader for bicycle lanes and for motorways

Picture 3 and 4: Liquid Spreader in action; Liquid Spreader on a trailer

Spreaders for liquid spreading are produced in every size, from very big versions for motorways down to small sizes for bicycle lanes. Especially on bicycle lanes liquid spreading has big advantages because here is the distribution of the salt and the thawing help by the traffic not so good as it is on raods.

For curative spreading, spreading of great amounts and spreading at very low temperatures nevertheless pre-wetted spreading is the best method. So the future winter maintenance strategy needs spreader for pre-wetted salting and spreader for liquid salting.

Therefore the spreader producers in Germany developed combined spreader which can do both, pre-wetted spreading with a spreading disc and liquid spreading with spray nozzles. This type of spreader is very flexible and effective.

But there is a problem when doing liquid spreading: although a lower amount of salt is necessary the spreading density is higher than this of pre-wetting because the brine has a concentration of about 20 %. So a bigger capacity for the brine tank is needed to spread the same road length. Result of this is that for motorways very big tanks and trucks are needed, and combined spreaders are not always effective because of the reduced brine capacity.

Picture 5: Big combined spreader for motorways with spreading disc and nozzles

In each situation it is necessary to calculate what capacity is needed and what will be the most effective solution. For urban roads in the cities normally combined spreaders are most effective, on motorways and rural roads it depend on the special situation; normally here are needed big trucks.

Since 2010 after the first results of the research projects liquid spreading in Germany went into practical use, since 2012 it is recommended for winter maintenance in Germany. Because this technique needs new or additional spreader it will last several years until it will be standard all over Germany, but most of the winter maintenance operators now have at least a part of these spreaders and are able to do the preventive spreading in optimal way.

5. SPREADING DURING SNOWFALL

Another question analysed in Germany in the last time was the spreading amount during snowfall. It is an old experience that it is good to spread salt in the falling snow to hold the snow loose and better removable later.

Up to now we recommended for this spreading in the falling snow maximum spreading densities of 30 or 40 g/m². This leads to big salt consumptions in times with heavy snowfall and in consequence to big costs and to problems of the salt supply in strong winter periods.

After the strong winter periods in Germany with big salt shortness this exercise was put into question, the more so as many operators reduced the spreading amounts during snowfall when salt became short.

Picture 6: Spreading during snowfall

Calculations and theoretical advisements show that salt spreading during snowfall can not have the task to melt the snow. Because even for melting 1 cm of Snow you need depending on the surface temperature the maximum spreading density or more. So it is not possible to melt the snow with salt. It is only possible to hold the snow loose and removable; based on practical experiences this can be reached with lower densities like 10 to 15 g/m². There is started a research project to clear up these interrelationships clearer and in detail, but meanwhile it is possible to reduce the spreading amounts during snowfall.

The new recommendation for snowfall situations in Germany is:

1. Preventive spreading before snowfall if possible with liquid or pre-wetted salt to have a salt film between road surface and snow to prevent the snow from freezing on the surface
2. Spreading in the falling snow while removing the snow with low densities of 10 to 15 g/m² to hold the snow removable
3. After end of snowfall mechanical removal of the snow as good as possible and spreading with high density to melt the remaining snow and ice

Because of the high need of salt for melting the snow it is very important to have a good removal quality. As more snow remains on the surface after plowing as more salt is needed. So a good and aggressive removal will save much salt and money.

Picture 7: Example for aggressive plowing with double-blade snowplow

A good and effective winter maintenance needs good and aggressive snow plows, and the drivers should be intensively trained in good plowing.

6. NEW RECOMMENDATIONS FOR PRACTICAL WINTER MAINTENANCE

These new findings and knowledge concerning preventive spreading, liquid spreading and spreading during snowfall have to be implemented in the practical winter maintenance.

This needs new equipment (liquid spreaders, combined spreaders, bigger trucks, aggressive snow plows), but also clear instructions and intensive trainings for the maintenance staff.

The new winter maintenance strategy subject to the weather and road condition is shown in table 1.

These new recommendations were concentrated on one sheet for the maintenance staff giving instructions for each weather and surface conditions and guide values for the spreading density subject to the surface temperature. The experiences with this new recommendations are positive and much better than in former times when there are given only general advices without guide values.

Expected Surface Condition	Recommended Winter Maintenance Action	Recommended Spreading Density ***
Hoarfrost	Preventive Spreading** - preferential Liquid Spreading* - otherwise Pre-Wetted Salt	 10 – 15 ml/m² 5 – 15 g/m²
Light Black Ice (freezing moisture)	Preventive Spreading** - preferential Liquid Spreading* - otherwise Pre-Wetted Salt	 10 – 25 ml/m² 5 – 30 g/m²
Black Ice (freezing wetness)	Preventive Spreading** - Pre-Wetted Salt or Liquid Spreading*	 15 – 40 g/m² (20 – 50 ml/m²)
Freezing Rain (black ice)	If possible Preventive Spreading** - preferential Liquid Spreading* - otherwise Pre-Wetted Salt	 40 – 60 ml/m² 30 – 40 g/m²
Snow Fall (packed snow)	1. Where possible Preventive Spreading with Liquid Spreading* or Pre-Wetted Salt 2. During Snow Fall Snow Removal and Spreading of Pre-Wetted Salt with low spreading density 3. After Snow Fall aggressive Removal of Snow and Spreading with Pre-Wetted Salt	15 – 30 ml/m² (10 – 20 g/m²) 10 – 15 g/m² 20 – 40 g/m²
	* *Liquid Spreading only at temperatures above -6°C, at lower temperatures only Pre-Wetted Salt* ** *if preventive salting was not possible, existing slipperiness must be eliminated with Pre-Wetted Salt with double spreading density*	*** *low values for temperatures tight below 0°C, higher values for lower temperatures*

Table 1: New Recommendations for Winter Maintenance Strategy in Germany

After full implementation of the new maintenance strategy it is possible to make winter maintenance much more effective. Times with slippery road conditions, winter accidents and congestions can be reduced, and at the same time also the needed salt amounts are lower. So this brings a big step forward for the winter maintenance.

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