RECOMMENDATIONS FOR THE CORRECT SPREADING OF MELTING SALT SOLUTIONS

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ABSTRACT

According to the analyses conducted on behalf of the Bundesanstalt für Straßenwesen (Federal Highway Research Institute - BASt) completed in 2009, it is also the case that when applying FS 30 (70% salt / 30% brine) prewetted melting agent a significant proportion of the spreading material (up to 85%) is transported by traffic from the road surface before it has had time to have an effect. These investigations led to the thesis that significantly less spreading material losses may be anticipated with the use of melting salt solutions.

The object of the research topic was to secure precise data as to which spreading densities achieve comparable results as with the use of FS 30 pre-wetted melting salt when salt solutions are applied, taking ambient conditions (water film thicknesses, temperatures) into consideration. Another thing to be determined, moreover, was if the salt spread via melting salt solutions could be expected to have a longer staying period than the dry components in FS 30.

The staying period of the melting salt solution was analysed at measured intervals under the impact of traffic conditions. The measurement areas were arranged on the right-hand side lane both between the wheel tracks and in the right wheel track. The following measurement methodology proved itself to be especially suitable during the course of the analysis:

1. Baseline measurement prior to application of brine
2. Measurement directly following application of brine
3. Measurement after one hour of traffic impact
4. Measurement after four hours of traffic impact
5. Measurement after 20-22 hours of traffic impact.

The measurements showed that with preventative spreading, which uses FS 100 (100% brine) technology, approximately 60% NaCl is saved. The preventative application of brine enables 1.5 times of the spreading material volume to be used compared to that when FS 30 technology is used. Environmental impacts are significantly reduced in relation to winter road services.

The application of FS 100 requires new technology for spreading and supplying the liquid melting material. The investment required here is covered by the savings made in relation to spreading materials.

1. Task definition

Alongside snow-clearing, melting spreading materials are the most effective means for tackling icy winter conditions. Sodium chloride as a melting material is used in the majority of situations to provide better distribution and adhesion to the road surface when combined with pre-wetted salt technology.

According to the analyses conducted on behalf of the Bundesanstalt für Straßenwesen (Federal Highway Research Institute - BASt) completed in 2009, it is also the case that when applying the FS 30 pre-wetted melting agent a significant proportion of the spreading material (up to 85%) is transported by traffic from the road surface before it has had time to have an effect [1], [2], [3]. These investigations led to the thesis that significantly less spreading material losses may be anticipated with the preventative use of melting salt solutions.

In Germany no comprehensive research has been conducted into the use of pure melting salt solutions in mobile road servicing operations. Before any such application may be commenced, it is necessary to ascertain the exact application conditions for melting salt solutions in relation to effectiveness, economy, traffic safety and ecology.

The aim of the research is to deepen and ascertain findings relating to the use of melting salt solutions in winter road servicing. In this context there is an opportunity to save considerable quantities of melting materials through the intelligent use of salt solutions in suitable winter weather conditions without negatively impacting on road safety. This brings the simultaneous possibility of saving on costs.

The object of the research subject is to secure precise data as to which spreading densities achieve comparable results as with the use of FS 30 pre-wetted melting salt when salt solutions are applied, taking ambient conditions (water film thicknesses, temperatures) into consideration. Another thing to be determined was if the salt spread via melting salt solutions could be expected to have a longer staying period than the dry components in FS 30.

The sparing use of melting materials in winter road servicing is very important from an ecological and economic perspective. The research can contribute to strategically exploiting identified savings potentials in this area. The savings potential particularly lies in efficiently preventing icy conditions commonly experienced in Europe with low water film thicknesses or to tackle them with a low amount of melting material.

A positive outcome of these investigations will impact on developments within the spreading equipment industry and also encompasses considerations concerning the future equipping of councils and commercial operations which perform winter road servicing.

2. Research methodology

Defined amounts of brine were laid on both dry or slightly wetted road surfaces. In order to create conditions as true to reality as possible, those lanes alongside the analysed lane were also treated with brine. Spreading material was deliberately not applied to the hard shoulders.

The staying period of the melting salt solution was examined at measured intervals under the influence of traffic conditions. The rinsing-suction device from ESG was used for this purpose (**Figure 1**).

Figure 1: Collecting spreading material using the rinsing-suction device

The measurement areas were arranged on the right-hand side lane both between the wheel tracks and in the right wheel track (Figure 2). Measurements were performed twice based on this arrangement. Furthermore, each measurement field was traversed two times.

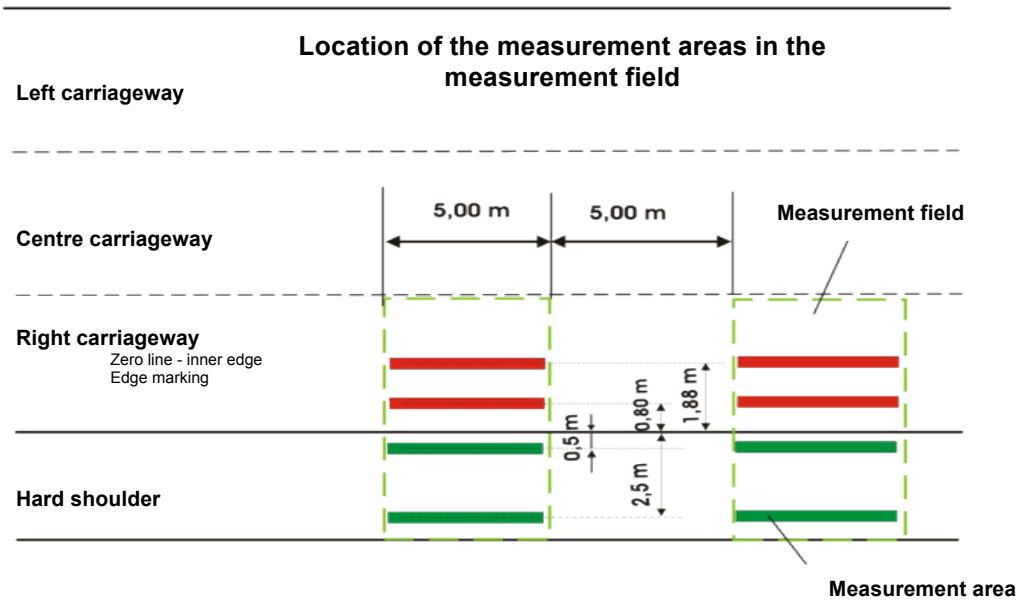

Figure 2: Position of the measurement areas

The following measurement methodology proved itself to be especially suitable during the course of the analyses:

6. Baseline measurement prior to application of brine
7. Measurement directly following application of brine
8. Measurement following one hour of traffic effect

9. Measurement after four hours of traffic effect

10. Measurement after 20-22 hours of traffic effect.

For the investigation of the residual salt concentration use was made of the new rinse-suction device which, according to recent findings, demonstrates better measurement precision compared to the devices employed in the known international research programmes.

Furthermore, in the areas in which salt solutions were applied observational data was also recorded, which is suitable for evaluating the duration of efficacy and certainty of efficacy of brine technology under various meteorological conditions.

3. Technology for deploying brine

During the tests, six different spraying machines were used.

1. Küpper-Weisser combination spreading machine - motorway maintenance department Erkner (**Figure 3**)
2. Epoke liquid spreader SL-E – motorway maintenance department Herford (**Figure 4**)
3. Küpper-Weisser liquid spreading machine Berlin city cleaning department (**Figure 5**)
4. Schmidt liquid spreader – Berlin city cleaning department (**Figure 6**)
5. Küpper-Weisser combination spreading machine motorway maintenance department Mendig (Figure 7)
6. Küpper-Weisser liquid spraying machine – motorway maintenance department Rottweil (**Figure 8**)

In all machines, the brine is discharged through nozzles. Thereby, in the area of the vehicle width, flat jet nozzles are used and for the area across the width of the vehicle, wide jet nozzles are used. The exact setting of the nozzles is of decisive significance for the lateral distribution of the brine. For the machines used, there were frequent deviations at the measurement surfaces for the spray density set. The greatest deviations were measured in the area of the wide jet nozzles.

Figure 3: Küpper-Weisser combination spreading machine with a set spray density of 20 g/m² and spray width of 11.25 m

Figure 4: Epoke liquid spreader with a set spray density of 20 ml/m² and spray width of 11.00 m

Figure 5: Küpper-Weisser liquid spraying machine with a set spray density of 20 g/m² and spray width of 7.50 m

Figure 6: Schmidt liquid spreading machine with a set spray density of 40 g/m² and spray width of 11.25 m

Figure 7: Combination spreading machine from Küpper-Weisser for 10000 l brine and 5 cbm dry salt

Figure 8: Küpper-Weisser spraying machine of the motorway maintenance department Rottweil

4. Results of the investigation

The measurements taken confirm that the salt proportion of salt solutions in preventative applications has, under the impact of road traffic, a significantly longer staying time than salt which is spread using FS30 technology.

The brine technology will contribute to being able to prevent slippery frost and black ice with a higher degree of certainty. The resulting increase in road safety reduces the number of accidents and generates macro-economic benefits.

Following a FS30 spreading after one hour of traffic impact only about 20% of the salt spread still remained on the road surface. If the salt is applied in solution form as brine, after one hour approximately 70% of the applied salt is still on the road surface (Figure 9).

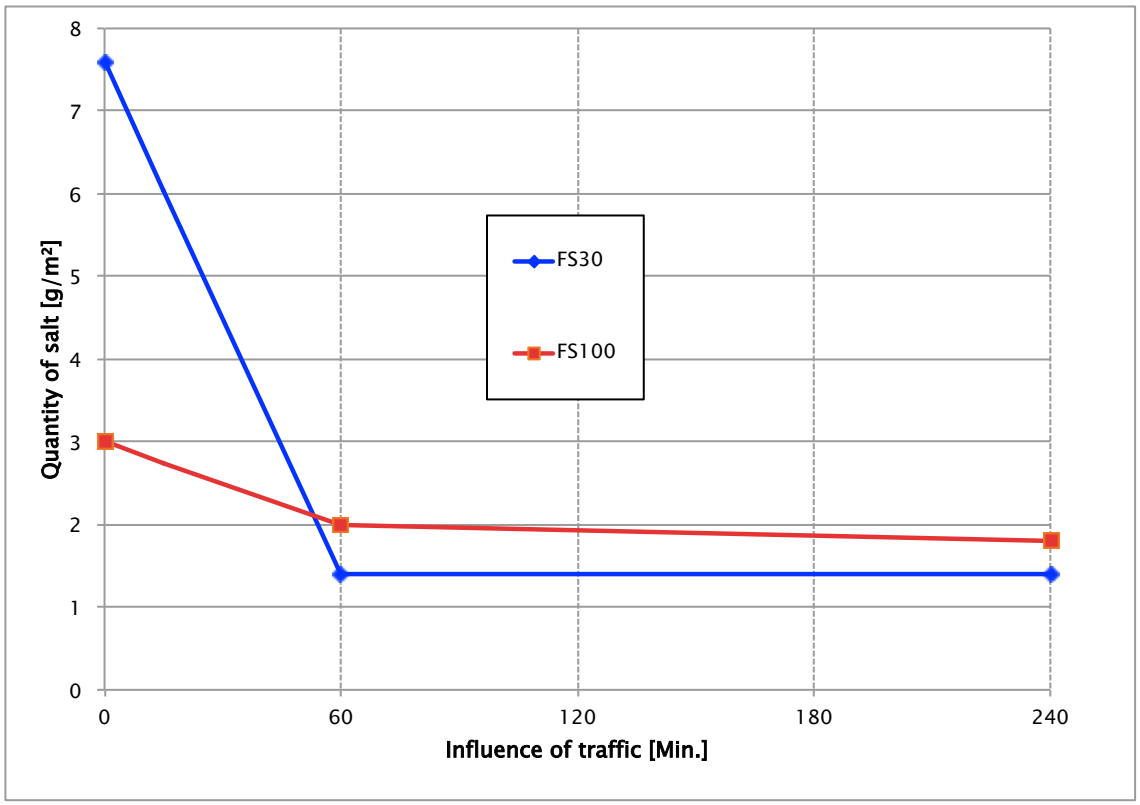

Figure 9 - Comparison of the loss of de-icing material after preventive spreading, due to the influence of traffic

With preventative spreading approximately 60% melting material can be saved through the use of FS100 technology. Environmental impacts are therefore significantly reduced in relation to winter road services.

The economic bottom line of brine technology is dependent on the technological circumstances prevailing in the given motorway service centre. Cost savings can be achieved in the majority of cases.

From the measurements taken it can be clearly seen that the staying period of the brine is subject to extremely complex effects resulting from the various influencing factors. Due to the complexity of these influencing factors, which can hardly be controlled and isolated during the recording of field measurements, it was necessary to take the greatest possible number of measurements under changing conditions.

The measurements on different days and locations showed a comparatively high spread of results. Details about pronouncements regarding the staying period are therefore not yet totally certain.

The performance of additional measurements during winter 2010/11 led to increased statistical certainty of the results. But it had to be noted that the initially supposed effects on influencing factors on the staying period – which were supported by the initial measurements – could not be confirmed.

Staff openly welcomed the new technology. The benefits of the spreading of brine for preventative applications were clearly evident to the users.

5. Consequences in practice

The results show that the strengthened brine application is a melting material that represents an economic addition to FS 30 technology and so constitutes a new step towards the intelligent application of winter road services [4].

The brine technology (FS 100) has benefits compared to the FS 30 technology particularly in relation to preventative applications.

The benefits are found in the longer staying time of the salt component of the brine on the road surface. This then provides a significantly longer period for preventative deployments prior to forecasted icy conditions. Significantly lower amounts of melting material are used as a result.

According to current results the recommended dosage of brine is 1.5 times the dosage of FS 30 for preventative applications. For example, this means that instead of 10 g/m^2 of FS 30, 15 g/m^2 of FS 100 is spread.

The application of FS 100 requires new technology for spreading and supplying the liquid melting material. Depending on the technological framework conditions, combination machines (FS 30/FS 100) and pure spreading machines are suitable. The brine should preferably be prepared on-site using special preparation equipment.

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KEYWORDS

WINTER MAINTENANCE / MELTING SALT / BRINE / SALT SOLUTUION