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REPORT *Winter Road Maintenance*

ANTI-SKID TREATMENT
Tests with Glucose / Fructose/Unrefined sugar
Sub-report I

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SUMMARY
The purpose of the investigation has been to perform tests with salt solution in combination with glucose/fructose and unrefined sugar in order to determine whether a certain proportion of the salt solution can be replaced by a product of these substances.
The introductory sets of tests in 2004, which were performed on a runway, provided experience for the continued performance of the testing. This resulted, among other things, in the surfaces being constantly watered once the solution had been applied. This gave a leaching of the respective solution with the aim of being able to measure how the friction decreased as the preconditions for the solution gradually deteriorated. The results have varied and further tests where conducted the winterseason 2005/2006.
The fact that salt will continue to play an important role in anti-skid treatment is verified by the results of all the tests. This investigation has shown that it is possible to use a mixture of the salt solution that is today used for anti-skid treatment together with a glucose/fructose- or unrefined sugar as base product. How large a proportion of “sugar solution” should be used, and in what concentration, should be further studied both by more “airfield tests” as well as on a road that is in normal use. When “sugar” is broken down, oxygen is consumed. The degradation of the sugar/salt mixture by the micro-organisms is influenced by the presence of toxic substances such as metals, and should be studied both in the field and in the laboratory. Furthermore, a study should be made of oxygen consumption in recipients.

A summerizing report will be presented in by new year 2006/2007 including all the parameters, cost etc.

1 BACKGROUND

Over the past ten-year period, salt consumption on roads has halved from approximately 400 000 tonnes to some 200 000 tonnes per year. This is largely a result of preventive measures with salt solution which involve significantly smaller salt doses than with dry or moist salt.
Compared with the rest of Europe, which consumes approximately 9 million tonnes of salt per year, Sweden's consumption on the state road system is low.

2 GOAL AND PURPOSE

Vägverket's (SRA) ambition is to further reduce salt consumption on the state road network in Sweden without causing the deterioration of anti-skid treatment.
With the aim of reducing salt consumption, an attempt is being made in this project to see whether salt can to a certain extent be replaced by a sugar-based product, i.e. glucose/fructose and unrefined sugar.

3 IMPLEMENTATION

3.1 General

Tests have been carried out with salt solution and a product containing glucose/fructose and unrefined sugar on a disused airfield 2004/2005 and fullscale field tests 2005/2006.
In the tests, which can be compared with a laboratory test but on a larger scale, salt solution and sugar solution have been mixed together. The salt concentration in the salt solution has been "normal", i.e. a 23% solution. The sugar content in the sugar solution has varied from between 25 and 73%.

3.2 Testing 2004/2005

Two different types of sugar solution have been used. One solution consisted of pure sugar, and was referred to as "invert", while the other solution was "less pure" and referred to as "beta".
The test road consisted initially of the airport runway and subsequently of the taxiway that extends around the runway. The surface of the runway was divided up into a number of longitudinal sections that were in turn subdivided into six sub-sections each 200 m long. Between each sub-section a 100 m buffer zone was inserted. The taxiway was divided into 8 sub-sections each 120 m long with intermediate buffer zones.

3.2.1 Preconditions for all sections

Salt and sugar solution was mixed manually in containers in connection with the respective testing session. All the solutions were spread with the same equipment and by the same driver. In addition to solutions with different contents, pure water was also spread over the test sections in order to successively reduce the concentration of the solutions and in this way be able to follow how the friction level decreased as the leaching gradually took place.
For reference purposes, a reference section was also included on which only water was spread. Friction measurements were performed by the Swedish Road and Traffic Research Institute, VTI.

Spreading of the respective solutions was video filmed with the aim of later analysing the distribution patterns.
A journal has been kept of the times when different measures were started and finished.

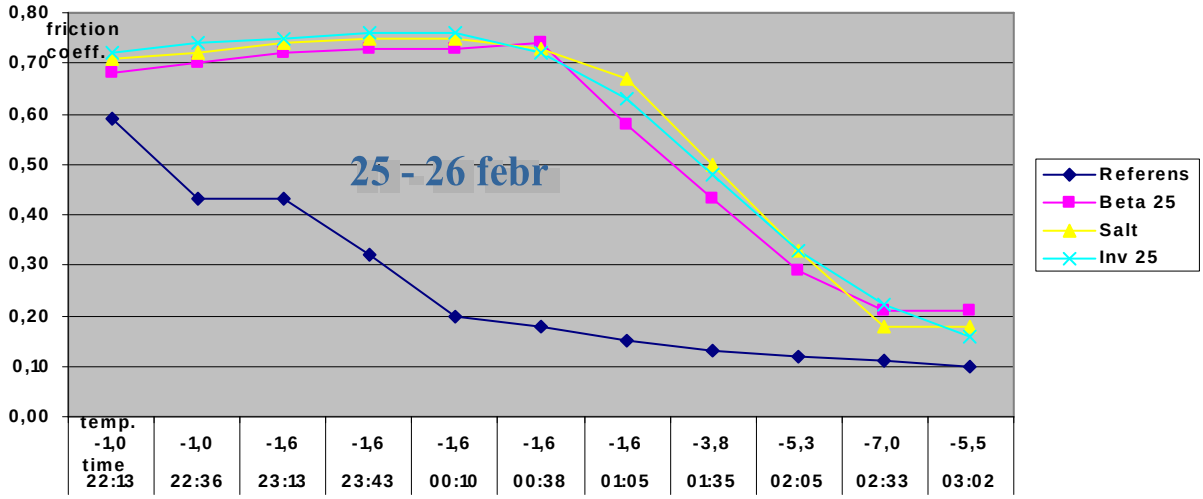
3.2.2 Results

General

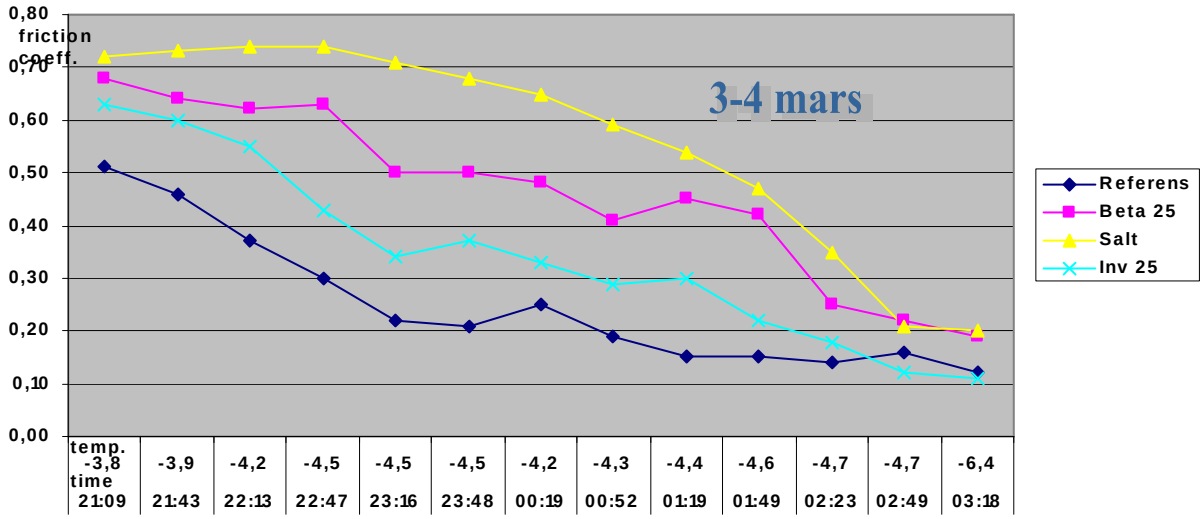
The initial testing that was carried out on the runway provided experience for the continued performance of the tests. Among other things, it resulted in the surfaces being constantly watered after the solutions had been applied. In this way, a leaching of the respective solutions was obtained in order to be able to measure how the friction values decreased as the preconditions for the solution gradually deteriorated. It is important to point out, however, that the quantity of water added amounted to an equivalent maximum of 0.5 mm of precipitation in the form of rain or approximately 0.5 cm of snow. Friction measurements, the results of which are presented both graphically and in tabular form, were carried out between two water applications.

Conclusion

The following graph shows the development for 100% salt solution and two mixtures of salt solution with 25 % glucose/fructose, both with a sugar concentration of 25 %. For the purpose of comparison, the reference section is also shown.



It is impossible to see any differences between the different solutions from the above graph!



The value of the salt solution is clearly higher than the two mixtures during the first few hours but deteriorates successively in comparison with the “beta mixture”.
The purpose of the investigation has been to perform tests with salt solution in combination with glucose/fructose in order to determine whether a certain proportion of the salt solution can be replaced by a product of these substances. The results have varied and further tests should be carried out during the coming winter 2005/2006. The fact that salt will continue to play a significant role in anti-skid protection is verified by this investigation. The investigation has shown that it is possible to use a mixture of the salt solution that is today used for anti-skid treatment together with a product of glucose/fructose. How large a proportion the “sugar solution” is and in what concentration should be further examined both by continued “airfield tests” as well as on operational roads.

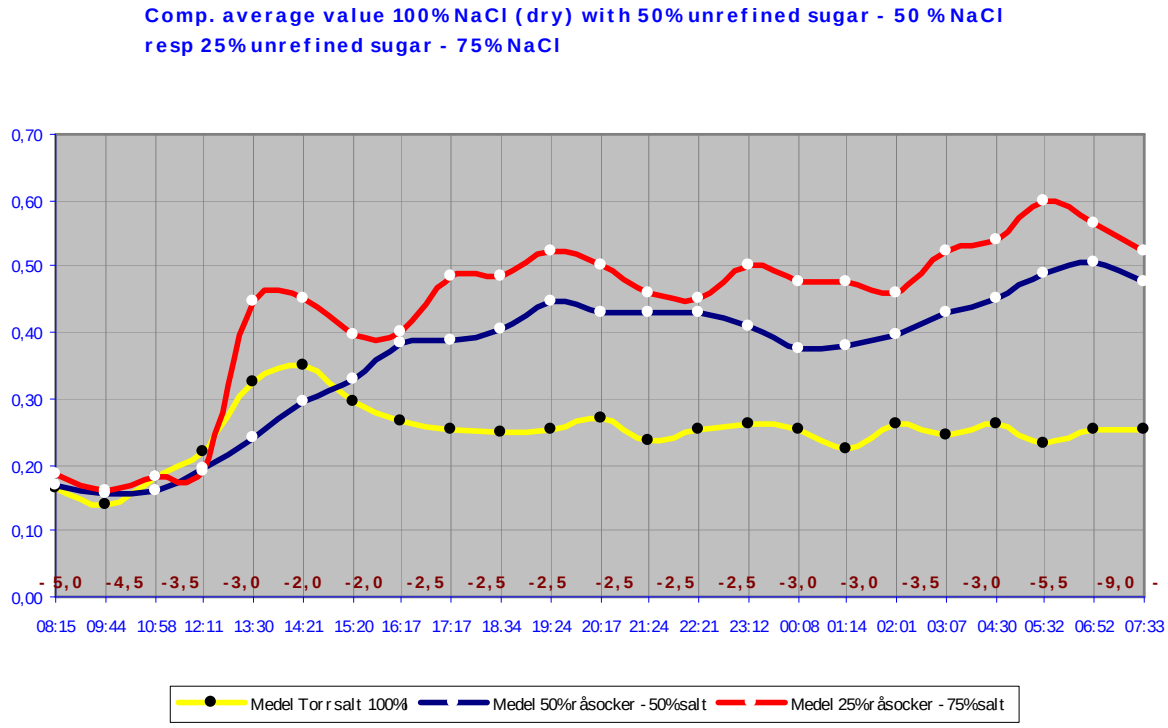
3.3 Testing 2005/2006

Fullscale fieldtests where carried out in Hagfors maintenance area in the mid-west part of Sweden during the season.

Fructose/glucose and unrefined sugar was tested in saltsolution for preventive use and also on snowy and icy road surface. The material was also used mixed in sand to prevent freezing.

The goal and purpose is to secure the product's (the mixture) friction, by friction measurements and to secure the enviromental impact as well as the impact on concrete, corrosion and animal life and plant life.

Conclusion



So far no significant differences in the results between unrefined sugar and fructose/glucose.
The sugarproduct can most likely be a mix substitute for 25 -50 per cent of the solution.
The the sugar solution can replace salt in sand to prevent the sand from freezing.

4. Enviroment

Oxygen is consumed in the degradation of glucose/fructose/unrefined sugar. The degradation velocity, and thus the oxygen supply, are dependent on parameters such as temperature, supply of nutrients and the kind of micro-organisms that are present in the environment that is exposed to the substance.
Deep groundwater sources and ice-covered surface watercourses are particularly exposed. The effects of degradation by micro-organisms of "sugar" and salt by the presence of toxic substances such as metals should be studied both in the field and the laboratory. Furthermore, oxygen consumption in recipients should be studied.