Laboratory and Field Evaluation of a Chloride-free Material for Snow and Ice Control

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Introduction

Application of anti-icing and deicing agents and other measures for preventing wet roads from becoming icy are important for "ensuring safe and smooth winter road traffic".

Sodium chloride (SC) is the major deicing agent

Reasons why SC is applied:

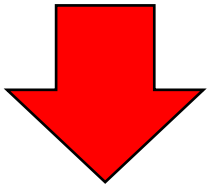
- ✓ Inexpensive
- ✓ Easily available in large quantities
- ✓ Highly effective in melting ice
- ✓ Easy to deliver, store, and load onto vehicles

Sodium chloride(SC)

Background and Aim of Study

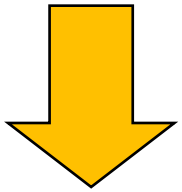
Although SC is the major deicing agent,

There is a concern over negative impacts on the roadside environment caused by the application of chloride



- ✓ Vehicles
- ✓ Bridges and other roadside structures
- ✓ Soil, plants, etc.

Development of a new chloride-free deicing agent that does not significantly damage the roadside environment



Survey of various compounds in search for the best available deicer

Tests focusing on Sodium propionate(SP)

- ✓ Laboratory metal corrosion test
- ✓ Application test at a test track

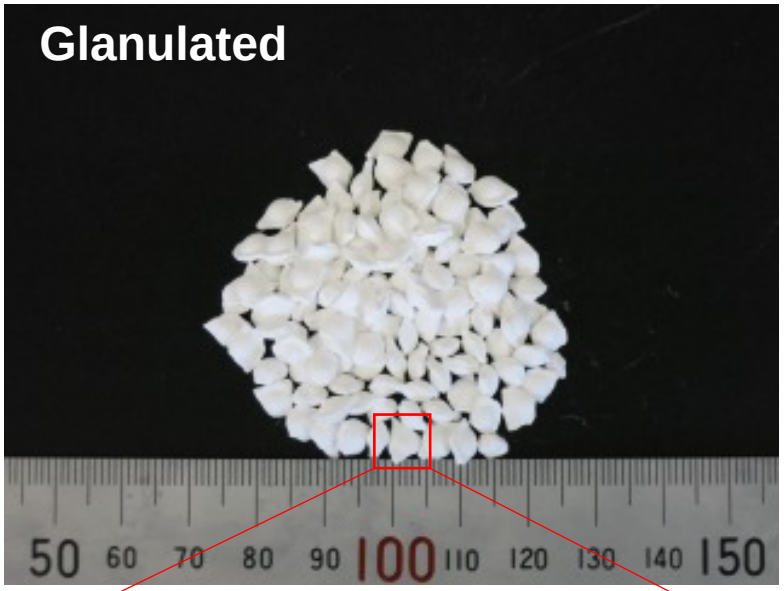
What is Sodium Propionate?

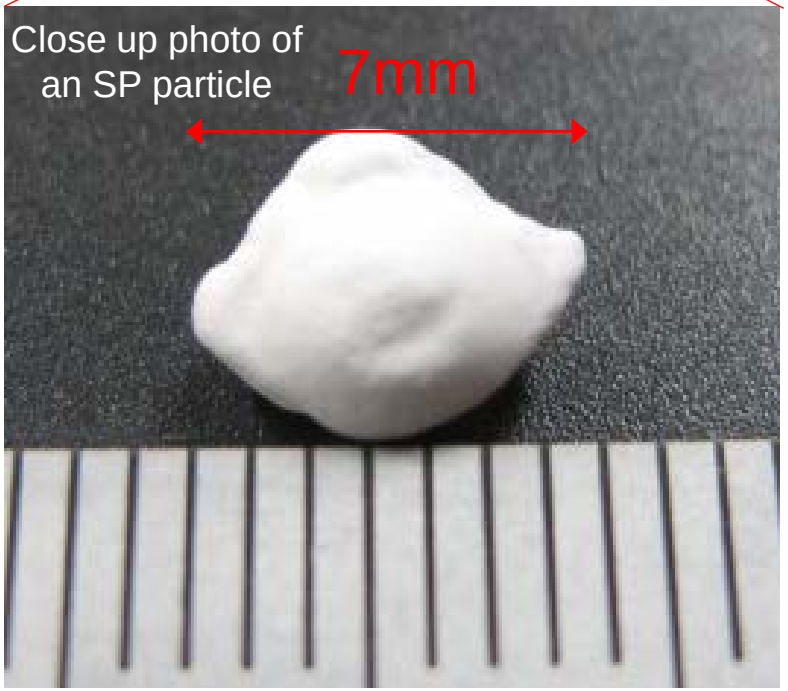
- ✓ General use: Used as a food preservative (i.e., fungicide)
  Food: Cheese, bread, cake
  Other products: Cosmetics, feed, paints, adhesives, etc.
- ✓ Retail price in Japan: US$10-15 / kg
  US$2 / kg for purchase of 10 tons at a time
- ✓ Form: Pulverized usually; Granulation possible
- ✓ Freezing point

Specimen (a 20%-by-mass solution)	Freezing point
SC	-19.1° C
SP	-16.1° C
SC + SP (weight ratio 8:2)	-18.9° C

State of SP


Powder
50 60 70 80 90 100 110 120 130 140 150


Glanulated
50 60 70 80 90 100 110 120 130 140 150


Close up photo of
an SP particle
7mm

Metal Corrosion Test Procedures

Metal corrosion test by using various deicers

1) A 3.0 g of test material is dissolved in 100 cc of distilled water for preparing a test solution;

2) An iron specimen without zinc coating, which was weighed beforehand, was immersed in a solution of each test material for 24 hours and then left to dry for 24 hours;

3) The immersion-and-dry cycle was repeatedly conducted for 7 days; and

4) On the 8th day, the rust was completely removed from the specimen, and the remaining iron piece was weighed to see the difference in weight before versus after rusting.

Metal Corrosion Test Results

Specimen	Amount of corrosion (mg / dm^2 × day)
Distilled water	8.6 mdd
SC	22.5 mdd
Calcium chloride (CC)	27.5 mdd
SP	0.3 mdd
SC + SP(weight ratio 8:2)	4.4 mdd

In comparison to distilled water and the solution of SC or of CC, the amount of corrosion was significantly smaller for the SP solution and the SC+SP mixture with a weight ratio of 8:2.

Metal corrosion damage to vehicles and roadside structures is reduced.

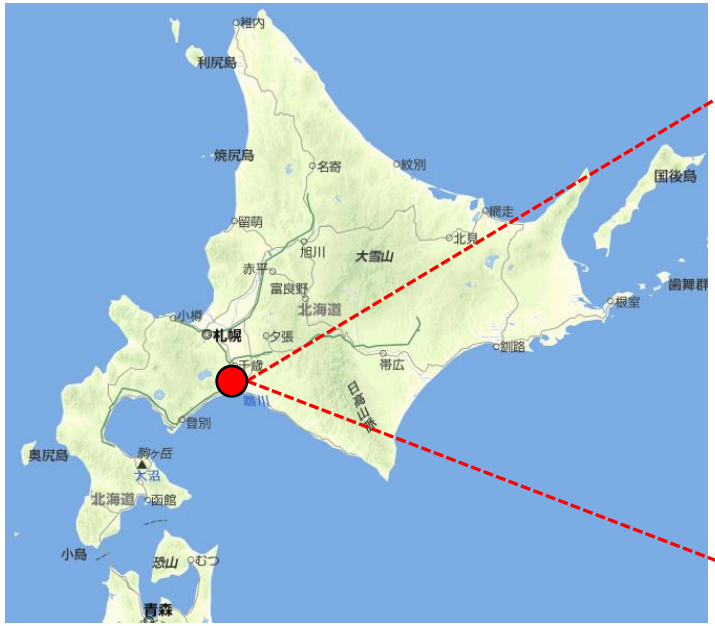
Test Method

Test day

January 21, 2015

Testing Location

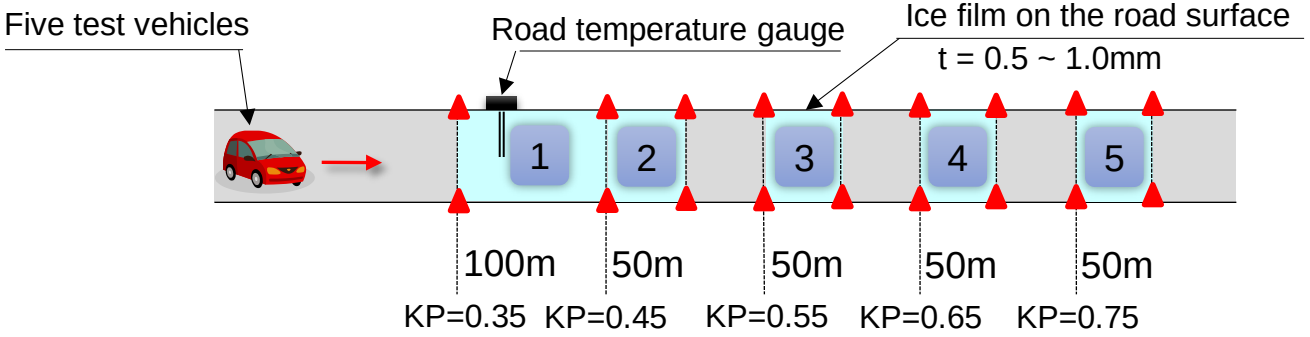
Tomakomai Winter Test Track(Length=2,700m)
Civil Engineering Research Institute for Cold Region
Public Works Research Institute



Tomakomai Winter Test Track

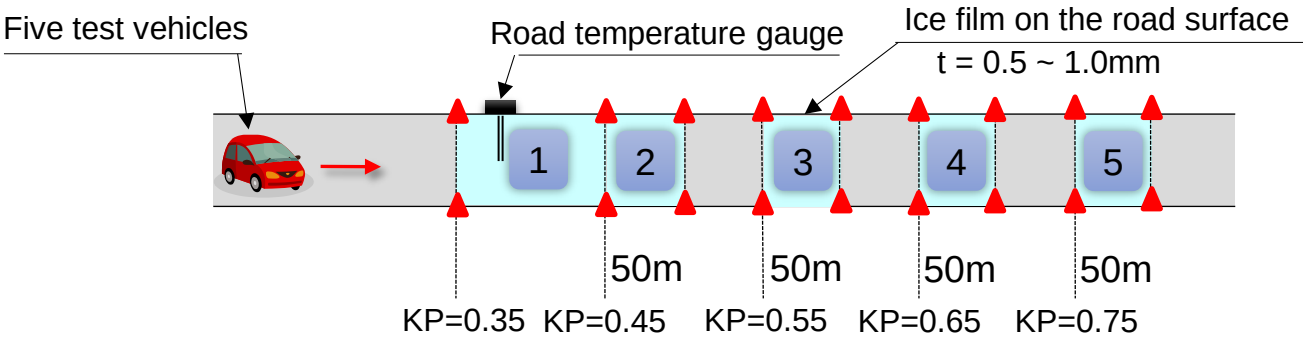
Test Method

Test day	January 21, 2015		
Weather	Fine		
Time	18:41 ~ 22:47		
Temp.	-6.0 ~ -3.8˚ C		
Road Temp.	-3.3 ~ -2.0˚ C		
Timing of spreading	Application after the track surface was frozen		
Test material	No treatment		NT
	SC	Dry spreading	SC
	SC + SP (weight ratio 8:2)	Dry spreading	SC+SP
	SC+SP solution (30 %-by-mass solution) (weight ratio 9:1)	Wet spreading	SC+SPS
	SC+CC solution (30 %-by-mass solution) (weight ratio 9:1)	Wet spreading	SC+CCS
Application rate	20 g/m2		



1. NT
2. SC
3. SC+SP
4. SC+SPS
5. SC+CCS

Test Procedures

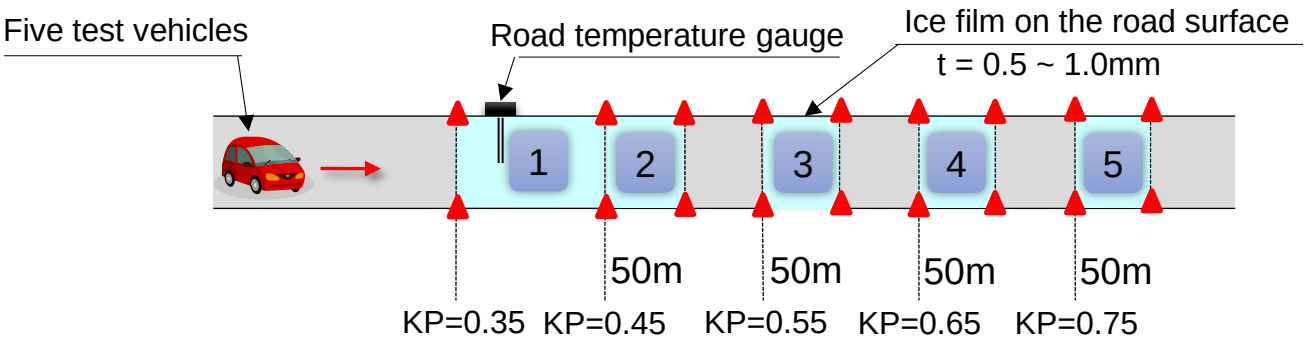


1. NT
2. SC
3. SC+SP
4. SC+SPS
5. SC+CCS

Sprinkling water for making ice film on the surface

Salt application

Test Procedures



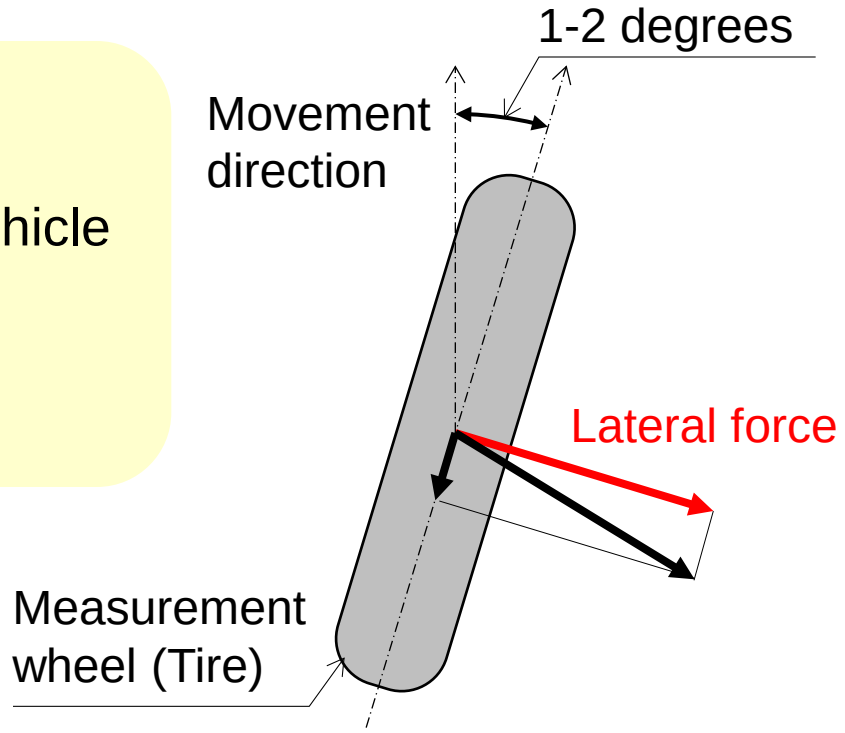
1. NT
2. SC
3. SC+SP
4. SC+SPS
5. SC+CCS

Skid resistance measurement

5 test vehicles traveling in the test sections

Continuous Friction Tester (CFT)

- Developed in the U.S.
- Measures friction continuously
- Measurement wheel attached to a vehicle
- Measuring wheel offset 1-2 degrees
- Measures transverse force
- Skid resistance expressed by “HFN”



Skid resistance measurement principle

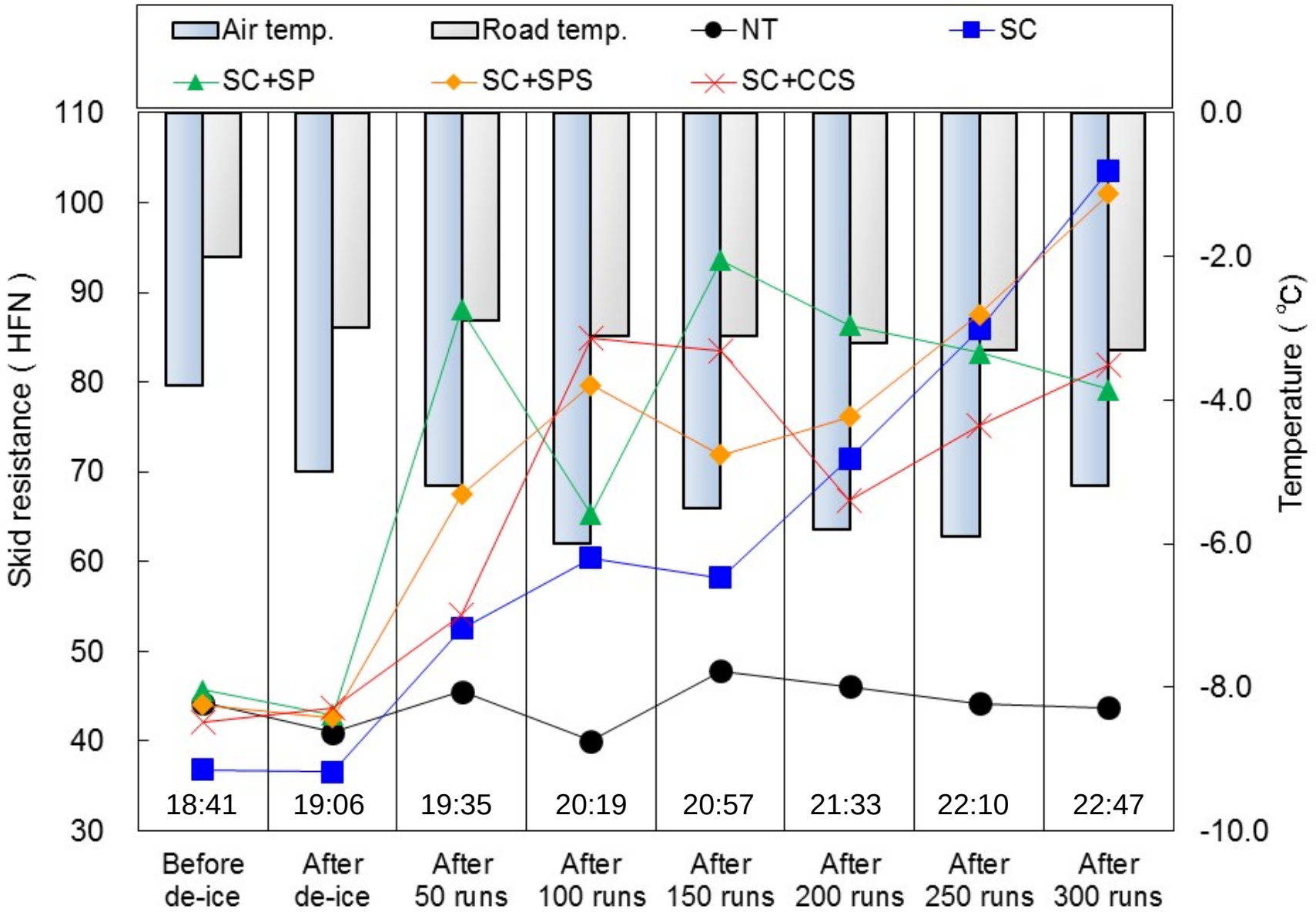
CFT

HFN: Halliday Friction Number

0 (no load)

100 (dry pavement)

Test Results



Summary and Future Study

- Results of the metal corrosion test

  SP helps reduce the amount of metal corrosion even when it is mixed with SC.

- Results of the application test

  Dry application of an SC+SP mixture as well as wet application of SC mixed with an SP solution is as effective as dry application of SC and wet application of SC mixed with a CC solution in increasing the skid resistance.

Although SP is more expensive than SC,
costs can be controlled by using a mixture of SP and SC.

The research will be continued by focusing on the following topics with a view to increasing the use of SP as an deicer:

- ✓ Effectiveness of SP in melting ice
- ✓ Distribution and costs of SP
- ✓ Negative impacts caused by SP on soil, plant, and other aspects of the roadside environment

Thank you for your kind attention.

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