JOINT STOCK COMPANY PROBLEMATIKA

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

LITHUANIAN ROAD ADMINISTRATION

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XIVth International Winter Road Congress

„MATERIALS AND TECHNOLOGIES FOR WINTER ROAD MAINTENANCE IN LITHUANIA “

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MAIN PARTS OF THE PRESENTATION

I. INTRODUCTION:

- Purpose of research project,
- Phases of exploratory experiments,
- Testing samples of snow melting materials.

II. TESTS:

- Testing methods,
- Testing procedures.

III. TEST RESULTS:

- criteria of measurement,
- evaluation of the results obtained in the laboratory,
- the results of measuring on the road.

IV. CONCLUSIONS.

I. INTRODUCTION

- Purpose of research project

Three-year research project (2011-2014) m. “The study of effective winter road maintenance of Lithuanian roads of national importance”

The aim of the research project is to study the efficiency of five different snow melting materials (*here and after referred to as SMM*) **under different conditions** (*environment, weather, surface temperature, transport intensity*) **and with respect to the thickness of snow and ice layer.**

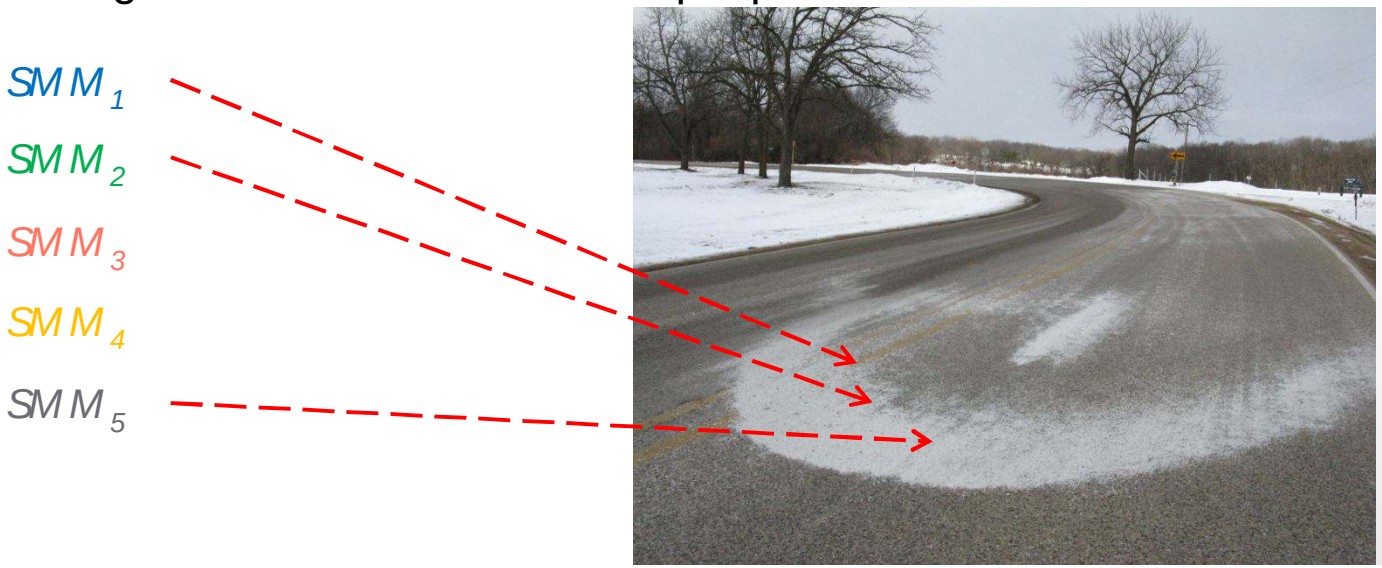
I. INTRODUCTION

- Phases of exploratory experiments

Phases of experiment:

1. The investigation of five different snow melting materials in laboratory *(test (ice) sample is effected under different constant temperatures and measurements are taken by applying SMM on the sample at different time intervals)*,

2. Measurements of experimental road sections effected by three snow melting materials with different properties.



I. INTRODUCTION

- Testing samples of snow melting materials.

Snow melting materials:

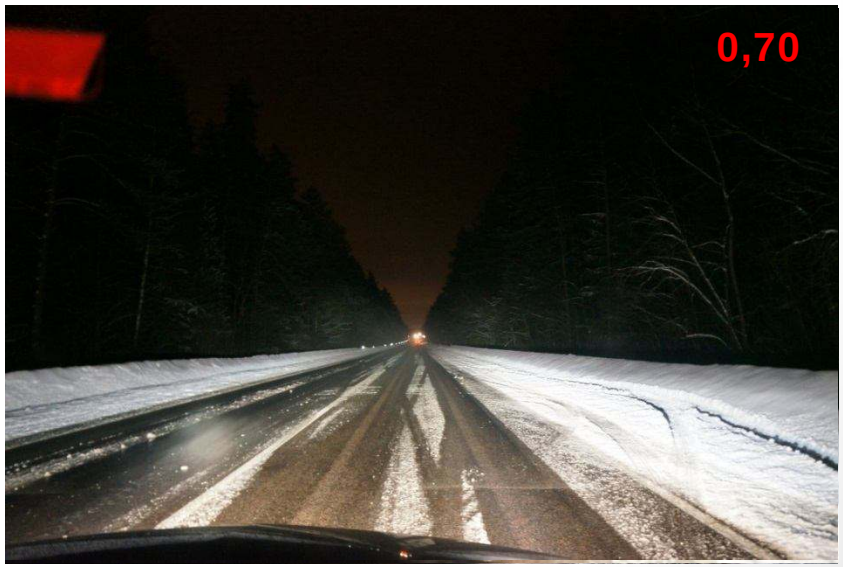
1. Sodium chloride (NaCl),
2. Calcium chloride ($CaCl_2$),
3. Magnesium chloride ($MgCl_2$),
4. A mixture of sodium and calcium modified chlorides (referred as SCMC),
5. A mixture of sodium acetate and sodium formate (referred as SASF).

II. TESTS

- Testing methods

Testing methods:

1. Laboratory tests on the efficiency of SMM and on the loss of ice mass,
2. Measurement of change in road slipperiness using optical remote sensor of Road Condition Monitoring (RCM 411).

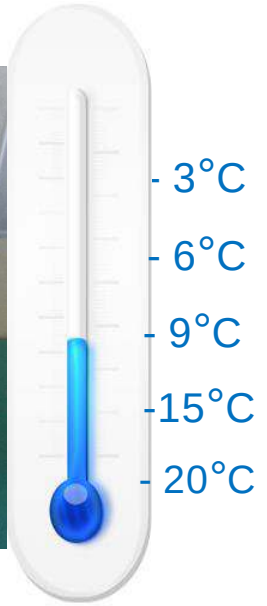


II. TESTS

- Testing procedure

Laboratory tests on the efficiency of SMM and on the loss of ice mass:

1. Preparing equal test (ice) samples,
2. Testing temperatures (-3, -6, -9, -15, -20) °C,
3. Measuring time intervals (4, 10, 20, 30, 60, 120) min.

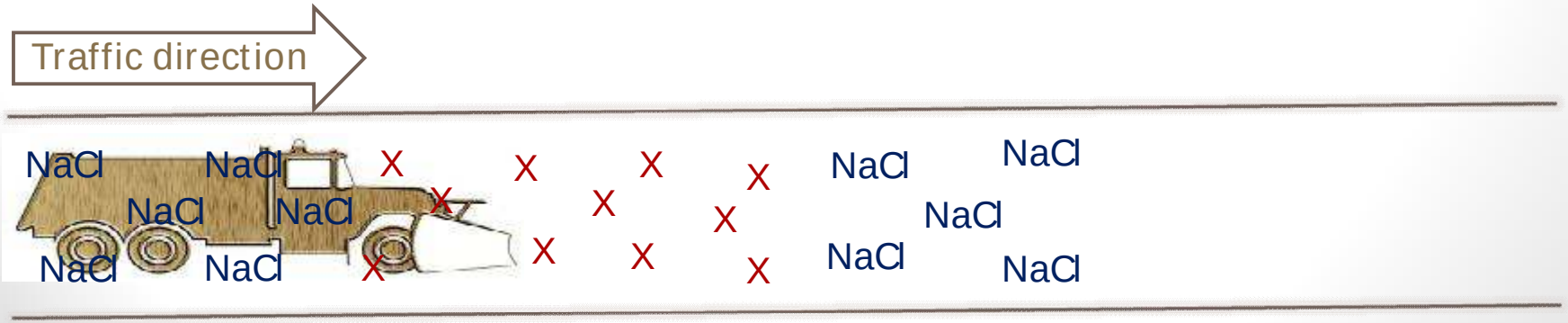


II. TESTS

- Testing procedure

Measurements of change in road slipperiness:

1. Same test road section was constructed on the road No. 107 Trakai–Vievis (14,32-15,52) km,
2. Experimental road was divided into three sections,
3. Two different SMMs were spread on those sections under different temperatures, precipitation conditions and with respect to the thickness of road surface (ice, snow, wet snow, etc.),
4. The change in slipperiness was measured and then analyzed under the same environmental conditions.



III. TEST RESULTS

- Criteria of measurement

Measurements in laboratory:

1. The change in ice mass loss (%),

The category of SRM efficiency	Ice mass losses, %
High efficiency	> 40
Average efficiency	20 - 40
Low efficiency	5 - 20
Inefficient	< 5

2. The intensity of ice melting (%/ min.),

The category of ice melting intensity	Ice melting intensity, %/ min.
High intensity	> 2
Average intensity	1 - 2
Low intensity	0,5 - 1
Very low intensity	< 0,5

III. TEST RESULTS

- Criteria of measurement

Measurements on road:

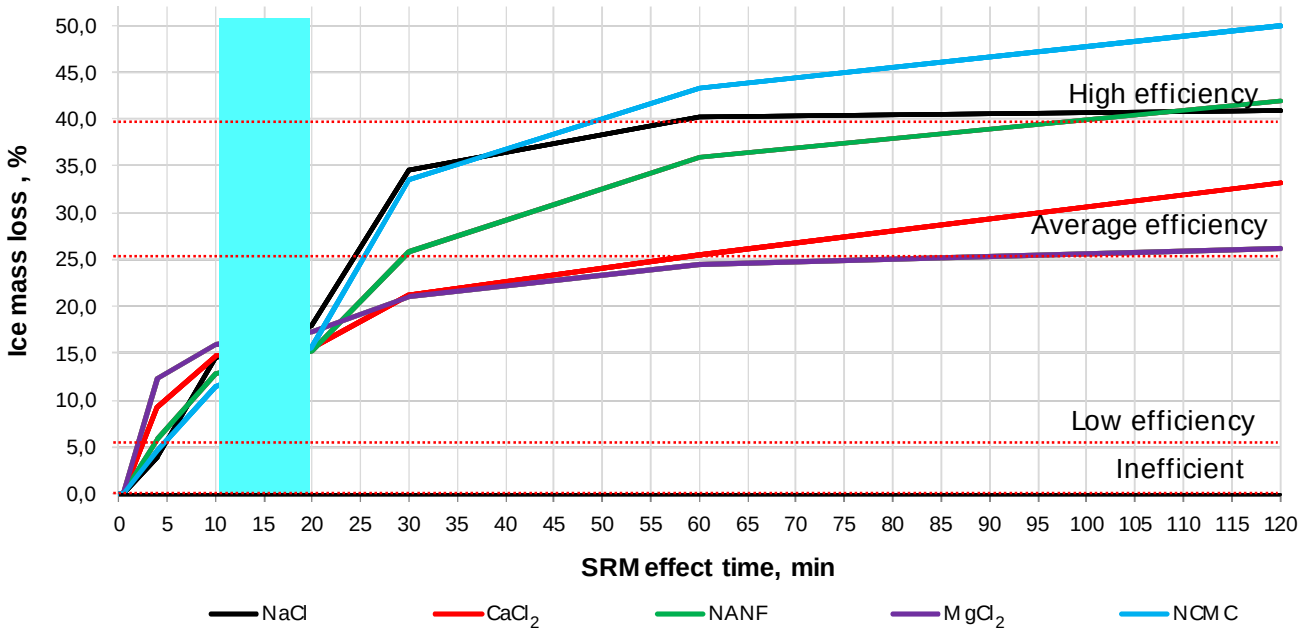
- Friction coefficient

Road surface/ driving conditions	friction coefficient
Dry road	> 0,80
Slippery road	0,80 – 0,40
Solid ice	< 0,4

III. TEST RESULTS

- Evaluation of the results obtained in the laboratory

The loss of ice mass (-3 °C), %



III. TEST RESULTS

- Evaluation of the results obtained in the laboratory

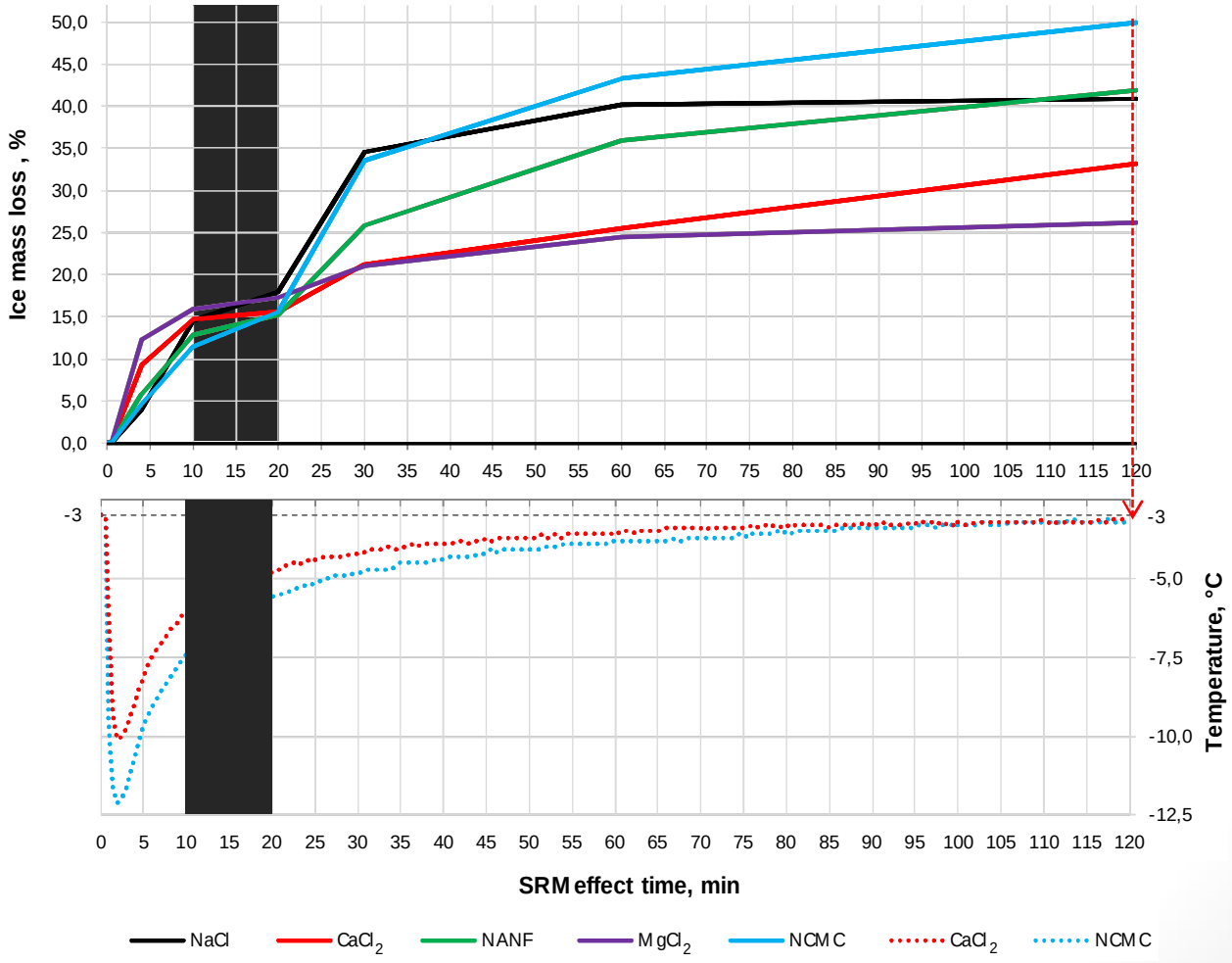
The intensity of ice melting, *%/min*

SRM	Time, min	Ice melting intensity, %/min				
		Temperature, °C				
		-3	-6	-9	-15	-20
NaCl	4	1,0	0,5	0,3	0,1	0,0
	10	1,7	1,0	0,5	0,2	0,0
	30	1,7	0,5	0,4	0,2	0,0
	60	0,2	0,2	0,0	0,0	0,0
	120	0,0	0,0	0,0	0,0	0,0
$CaCl_2$	4	2,3	2,0	2,0	1,2	0,9
	10	0,9	0,5	0,3	0,1	0,1
	30	0,6	0,2	0,3	0,0	0,0
	60	0,1	0,0	0,0	0,0	0,0
	120	0,1	0,0	0,0	0,0	0,0
NANF	4	1,4	0,7	0,3	0,1	0,0
	10	1.2	0.8	0.5	0.0	0.0
	30	1,1	0,5	0,1	0,1	0,0
	60	0,3	0,2	0,0	0,0	0,0
	120	0,1	0,0	0,0	0,0	0,0
$MgCl_2$	4	3,1	2,5	2,2	1,7	1,3
	10	0,6	0,4	0,4	-0,1	-0,2
	30	0,4	0,0	0,1	0,0	0,1
	60	0,1	0,1	0,0	0,0	0,0
	120	0,0	0,0	0,0	0,0	0,0
NCMC	4	1,1	0,8	1,0	0,4	0,3
	10	1,1	0,8	0,4	0,2	0,1
	30	1,8	0,7	0,3	0,1	0,0
	60	0,3	0,2	0,1	0,0	0,0
	120	0,1	0,0	0,0	0,0	0,0

III. TEST RESULTS

- Evaluation of the results obtained in the laboratory

The efficiency of SMM (-3 °C)



III. TEST RESULTS

- Evaluation of the results on the road

Measurements of experimental road sections

Test road section length, m	**1200**		
Test road section, m	400	400	400
Spreading material	Traditional spreading material (NaCl)	Test spreading material	Traditional spreading material (NaCl)

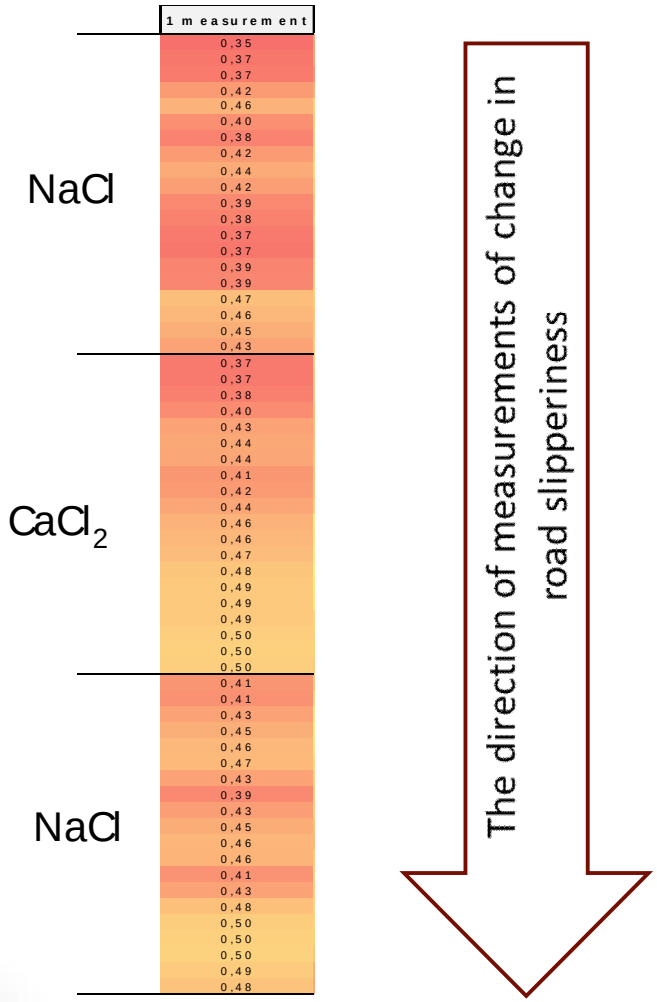
Test spreading SMMs:

1. Sodium chloride (NaCl),
2. calcium chloride ($CaCl_2$),
3. a mixture of sodium acetate and sodium formate (referred as SASF).

III. TEST RESULTS

- Evaluation of the results on the road

Color scale for the bond coeff.	0,43	0,49	0,50	0,50	0,51	0,52	0,56	0,67	0,70	0,74	0,76	0,79	0,79



III. TEST RESULTS

Measurements of change in road slipperiness

	1 measurement	2 measurement	3 measurement	4 measurement	5 measurement	6 measurement	7 measurement	8 measurement	9 measurement	10 measurement	11 measurement	12 measurement	13 measurement
NaCl	0,35	0,43	0,44	0,36	0,49	0,43	0,53	0,52	0,51	0,50	0,55	0,76	0,80
	0,37	0,43	0,44	0,35	0,46	0,43	0,54	0,49	0,51	0,49	0,55	0,76	0,80
	0,37	0,41	0,44	0,36	0,48	0,43	0,55	0,48	0,50	0,48	0,54	0,76	0,79
	0,42	0,45	0,47	0,34	0,49	0,41	0,49	0,52	0,50	0,51	0,64	0,75	0,79
	0,46	0,50	0,50	0,37	0,47	0,44	0,44	0,51	0,50	0,53	0,72	0,75	0,78
	0,40	0,50	0,46	0,45	0,47	0,48	0,43	0,50	0,49	0,56	0,76	0,67	0,78
	0,38	0,50	0,47	0,47	0,48	0,48	0,48	0,52	0,49	0,58	0,80	0,75	0,78
	0,42	0,50	0,49	0,47	0,48	0,47	0,50	0,55	0,47	0,73	0,80	0,78	0,79
	0,44	0,51	0,49	0,47	0,46	0,49	0,49	0,56	0,49	0,77	0,71	0,79	0,80
	0,42	0,49	0,49	0,48	0,47	0,49	0,49	0,56	0,52	0,70	0,53	0,79	0,80
	0,39	0,49	0,49	0,49	0,49	0,46	0,48	0,57	0,69	0,72	0,71	0,79	0,81
	0,38	0,50	0,48	0,49	0,49	0,47	0,48	0,59	0,73	0,75	0,78	0,80	0,80
	0,37	0,49	0,49	0,49	0,48	0,48	0,48	0,56	0,55	0,76	0,79	0,80	0,80
	0,37	0,48	0,50	0,49	0,46	0,48	0,48	0,54	0,56	0,71	0,79	0,80	0,80
	0,39	0,49	0,50	0,50	0,46	0,47	0,49	0,52	0,54	0,59	0,71	0,80	0,80
	0,39	0,50	0,49	0,49	0,47	0,46	0,47	0,52	0,51	0,54	0,55	0,80	0,80
	0,47	0,49	0,48	0,49	0,49	0,49	0,46	0,54	0,54	0,55	0,64	0,80	0,81
	0,46	0,48	0,48	0,49	0,50	0,50	0,46	0,51	0,51	0,74	0,76	0,80	0,80
	0,45	0,48	0,49	0,49	0,50	0,51	0,48	0,63	0,51	0,78	0,80	0,80	0,79
	0,43	0,50	0,49	0,49	0,50	0,50	0,50	0,71	0,55	0,80	0,80	0,79	0,79
$CaCl_2$	0,37	0,50	0,49	0,50	0,49	0,50	0,51	0,74	0,68	0,80	0,80	0,79	0,79
	0,37	0,49	0,49	0,51	0,49	0,51	0,51	0,74	0,72	0,81	0,80	0,79	0,79
	0,38	0,49	0,49	0,51	0,49	0,52	0,55	0,75	0,77	0,81	0,79	0,79	0,79
	0,40	0,48	0,48	0,52	0,51	0,54	0,52	0,76	0,78	0,81	0,79	0,79	0,79
	0,43	0,47	0,48	0,53	0,52	0,53	0,56	0,77	0,79	0,80	0,79	0,79	0,79
	0,44	0,47	0,49	0,53	0,53	0,54	0,60	0,78	0,80	0,80	0,79	0,79	0,79
	0,44	0,48	0,49	0,52	0,53	0,56	0,57	0,77	0,80	0,80	0,80	0,80	0,79
	0,41	0,49	0,49	0,50	0,52	0,55	0,54	0,76	0,80	0,80	0,80	0,80	0,79
	0,42	0,49	0,49	0,49	0,51	0,53	0,54	0,64	0,80	0,80	0,80	0,80	0,79
	0,44	0,50	0,49	0,49	0,51	0,52	0,55	0,57	0,80	0,80	0,80	0,80	0,79
	0,46	0,55	0,49	0,49	0,51	0,52	0,56	0,62	0,80	0,80	0,80	0,80	0,79
	0,46	0,56	0,50	0,48	0,51	0,52	0,57	0,68	0,80	0,80	0,80	0,79	0,80
	0,47	0,55	0,51	0,49	0,52	0,52	0,55	0,72	0,81	0,79	0,80	0,79	0,79
	0,48	0,55	0,53	0,52	0,53	0,53	0,56	0,75	0,81	0,79	0,80	0,79	0,79
	0,49	0,56	0,54	0,56	0,55	0,53	0,69	0,78	0,80	0,79	0,80	0,79	0,79
	0,49	0,53	0,54	0,56	0,56	0,52	0,76	0,79	0,80	0,79	0,79	0,79	0,79
	0,49	0,51	0,54	0,55	0,53	0,50	0,79	0,80	0,80	0,79	0,79	0,79	0,79
	0,50	0,50	0,54	0,55	0,50	0,62	0,80	0,79	0,80	0,79	0,79	0,79	0,79
	0,50	0,50	0,53	0,55	0,49	0,69	0,79	0,79	0,80	0,79	0,79	0,79	0,79
	0,50	0,49	0,52	0,57	0,52	0,67	0,78	0,79	0,80	0,79	0,79	0,79	0,79
NaCl	0,41	0,49	0,51	0,56	0,53	0,53	0,78	0,79	0,80	0,80	0,80	0,79	0,79
	0,41	0,51	0,55	0,59	0,52	0,54	0,80	0,79	0,80	0,79	0,80	0,79	0,79
	0,43	0,53	0,77	0,76	0,73	0,75	0,81	0,79	0,80	0,79	0,79	0,79	0,79
	0,45	0,55	0,71	0,80	0,78	0,79	0,80	0,79	0,79	0,79	0,79	0,78	0,79
	0,46	0,53	0,55	0,61	0,70	0,70	0,71	0,79	0,79	0,79	0,79	0,79	0,79
	0,47	0,51	0,51	0,51	0,54	0,57	0,57	0,80	0,80	0,80	0,80	0,79	0,80
	0,43	0,50	0,50	0,50	0,53	0,52	0,54	0,80	0,80	0,80	0,80	0,79	0,80
	0,39	0,50	0,50	0,52	0,53	0,52	0,52	0,80	0,80	0,80	0,79	0,79	0,80
	0,43	0,50	0,49	0,51	0,53	0,52	0,49	0,80	0,81	0,80	0,79	0,79	0,80
	0,45	0,47	0,48	0,50	0,52	0,51	0,47	0,79	0,80	0,80	0,80	0,80	0,80
	0,46	0,47	0,49	0,48	0,50	0,50	0,48	0,76	0,78	0,80	0,80	0,80	0,80
	0,46	0,49	0,49	0,48	0,50	0,50	0,50	0,66	0,70	0,80	0,80	0,80	0,80
	0,41	0,51	0,47	0,49	0,49	0,50	0,51	0,67	0,57	0,80	0,80	0,80	0,80
	0,43	0,50	0,48	0,49	0,50	0,50	0,57	0,72	0,73	0,80	0,81	0,80	0,79
	0,48	0,50	0,49	0,49	0,51	0,50	0,56	0,74	0,77	0,81	0,80	0,80	0,80
	0,50	0,50	0,50	0,49	0,51	0,49	0,50	0,74	0,79	0,81	0,80	0,80	0,80
	0,50	0,50	0,49	0,49	0,50	0,49	0,48	0,70	0,79	0,81	0,80	0,81	0,80
	0,50	0,48	0,49	0,49	0,50	0,49	0,47	0,60	0,79	0,80	0,81	0,80	0,80
	0,49	0,45	0,49	0,48	0,49	0,48	0,49	0,61	0,78	0,80	0,81	0,80	0,80
Color scale for the bond coeff.	**0,43**	**0,49**	**0,50**	**0,50**	**0,51**	**0,52**	**0,56**	**0,67**	**0,70**	**0,74**	**0,76**	**0,79**	**0,79**
Measurement time	04:22	04:59	05:09	05:19	05:29	05:39	05:49	05:58	06:07	06:16	06:26	06:36	06:46

IV. CONCLUSIONS

1. While conducting a laboratory experiment on the efficiency of SMM, it was observed that independently of environmental temperature and SMM used, ice melting intensity considerably reduced in the time interval from 10 to 20 min.
2. During the performance of road measurements the decrease of road surface friction was observed immediately after spreading SMM.
3. Testing methodology of ice melting efficiency was developed in order to find the cause of this phenomenon. The obtained results showed that a sudden decrease in temperature of ice surface, when it is affected by SMM, depends on the environmental temperature and chemical properties of SMM. The developed method allows to study the efficiency of SMM at different environmental temperatures.

IV. CONCLUSIONS

4. In accordance with the ice melting efficiency, SMM were divided into the following categories:

4.1. At a given environmental temperature (–3) °C, NaCl, SASF and SCMC are of high efficiency, while $CaCl_2$ and $MgCl_2$ are average efficiency SMM;

4.2. At a given environmental temperature (–6) °C, NaCl and SCMC are of average efficiency, while SASF, $CaCl_2$ and $MgCl_2$ are low efficiency SMM;

4.3. At a given environmental temperature (–9) °C, all tested SMM are of low efficiency;

4.4. At a given environmental temperature (–15) °C, $CaCl_2$ and $MgCl_2$ are of low efficiency, while NaCl, SASF and SCMC are ineffective.

4.5. At a given environmental temperature (–20) °C, $CaCl_2$ and $MgCl_2$ are of low efficiency, however they as well as NaCl, SASF and SCMC can be considered ineffective.

IV. CONCLUSIONS

5. In order to find out the efficiency of SMM, the required amount and concentration of the material and in order to achieve safe driving conditions in winter, it is necessary to conduct additional measurements, that would allow to develop a thermal map for a particular road section.

THANK YOU FOR YOUR ATTENTION