

A Study on Use of Quantitative Indicator to Support the Improvement of Winter Road Management

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Outlines

- Introduction
- Review
 - Winter Road Management Criteria
 - Methods for Measuring Friction
- Comparative Study of Friction Testers
- Using Friction Data
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 - Performance Evaluation
- Summary and Future Prospects

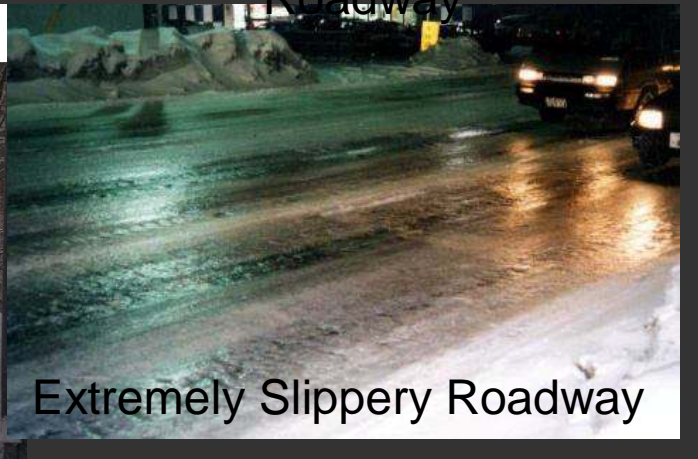
Introduction



Low Temperature & Heavy Snowfall



Traffic Jam caused by Narrow Roadway



Extremely Slippery Roadway



Snow Pile & Narrow Walkway

Introduction

- To ensure efficient and effective road surface management as part of winter road service in snowy cold regions, decisions should be made on the basis of easy and accurate understanding of surface conditions
- In order to contribute for more efficient winter road service in view of the recent financial constrains in Japan, CERI conducted a research on...
 - criteria for winter road surface management in the world
 - methods for quantitative evaluation of road surface
 - comparison study of friction measurement devices
 - utilization of friction data

Winter Road Management Criteria

- Japan

Road classification

Roadside Environment Daily Traffic Volume	Urban	Suburban or Rural (flat-land)	Mountainous
	20,000 ~	A	B
10,000 ~ 20,000	B	C	B
4,000 ~ 10,000	C	D	C
1,000 ~ 4,000	D	D	D
~1,000	E	E	E

Road surface conditions

LOS	Classification
1	<ul style="list-style-type: none"> Black Ice (thin ice) Very slippery Thick Ice Very Slippery Compacted Snow
2	<ul style="list-style-type: none"> Thick Ice Powder Snow over Thick Ice Thin ice
3	<ul style="list-style-type: none"> Granular Snow over Thick Ice Compacted Snow
4	<ul style="list-style-type: none"> Powder / Granular Snow Slushy
5	<ul style="list-style-type: none"> Wet / Dry (Free of snow & ice)

Road surface maintenance goals

Maintenance Goals	
A	<ul style="list-style-type: none"> Road surface LOS 4 to be ensured 24 hours a day
B	<ul style="list-style-type: none"> Road surface LOS 4 to be ensured between 6AM and 10PM At other hours, road surface LOS 3 to be ensured
C	<ul style="list-style-type: none"> Road surface LOS 3 to be ensured 24 hours a day
D	<ul style="list-style-type: none"> Road surface LOS 3 to be ensured between 6AM and 10PM At other hours, road surface LOS 2 to be ensured
E	<ul style="list-style-type: none"> In principal, road surface LOS 2 to be ensured 24 hours a day Appropriate maintenance operations shall be done based on the snow removal operations done and the traffic conditions along the route

Winter Road Management Criteria

- Europe

- Northern European countries have already introduced friction values as an index in winter road management and set standards in line with local meteorological conditions, time of day, road classifications and traffic volume

Quality standards of anti-icing (Finland)

maintenance class	Is	I	Ib
Normal	0.30	0.28	0.25
Friction requirement	road surface below -6 °C 0.25	road surface below -4 °C 0.25	spot sanding 0.25 line treatment 0.22
Cycle time	2 h	2 h	salt 3 h sand 4 h

Source: Snow and Ice Databook 2010

- North America

- Although some regions of North America also take friction measurements, such work are basically related to the management of “bare pavement (free of snow & ice)”, no detailed threshold values are set

Typical Canadian Level of Service Goals

	Expressways	Arterial Highways	Connector Roads	Local Roads
Maintenance Standard				
Surface Condition	Bare Pavement	Bare Pavement	Bare Centre Line	Snow packed with abrasive
Maximum Time to Level of Service	Within 4-12 hours after end of storm	Within 12 hours after end of storm	Within 12 hours after end of storm	Within 12-24 hours after end of storm
Snow Accumulation Trigger for Plowing	≥ 2 cm	≥ 2 cm	≥ 5 cm	≥ 8 cm
Material				
Salt	As Required	As Required	As Required	N/A
Sand	Surface Temperature ≤ -10 °C	Surface Temperature ≤ -10 °C	Surface Temperature ≤ -10 °C	As Required

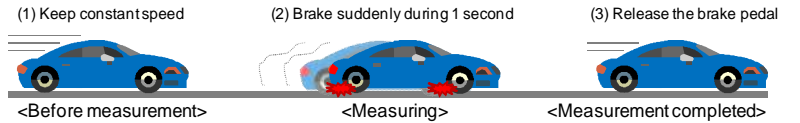
Source: Snow and Ice Databook 2010

Methods of Friction Measurement

Locked Wheel



Accelerometer



Slip Ratio



Side force



Tire Vibration



Non-contact sensor



Comparison Tests (Outlines)

- In order to understand basic characteristics of friction measurement devices comparison tests are conducted on CERI's Cold Region Test-track since 2007
- Friction devices used in the comparison test of 2013:
 - (A) Locked Wheel Friction Tester (LWFT – Full Brake)
 - (B) Continuous Friction Tester (CFT - Side Force)
 - (C) Non-contact sensor (IR - Infrared)



CERI's Test Track (Tomakomai)



Bus Type LWFT



Vehicle Equipped with CFT and IR

Comparison Tests (Outlines Cont.)

Dry (600m)



Wet (600m)



Compacted-Snow (400m)



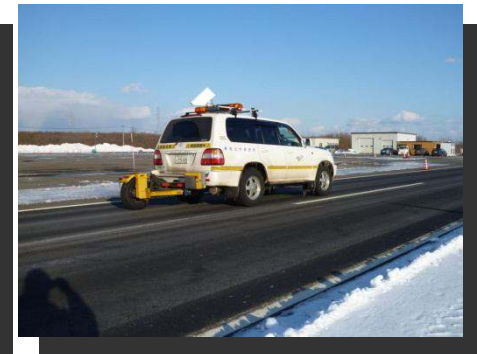
Thin-Ice (600m)



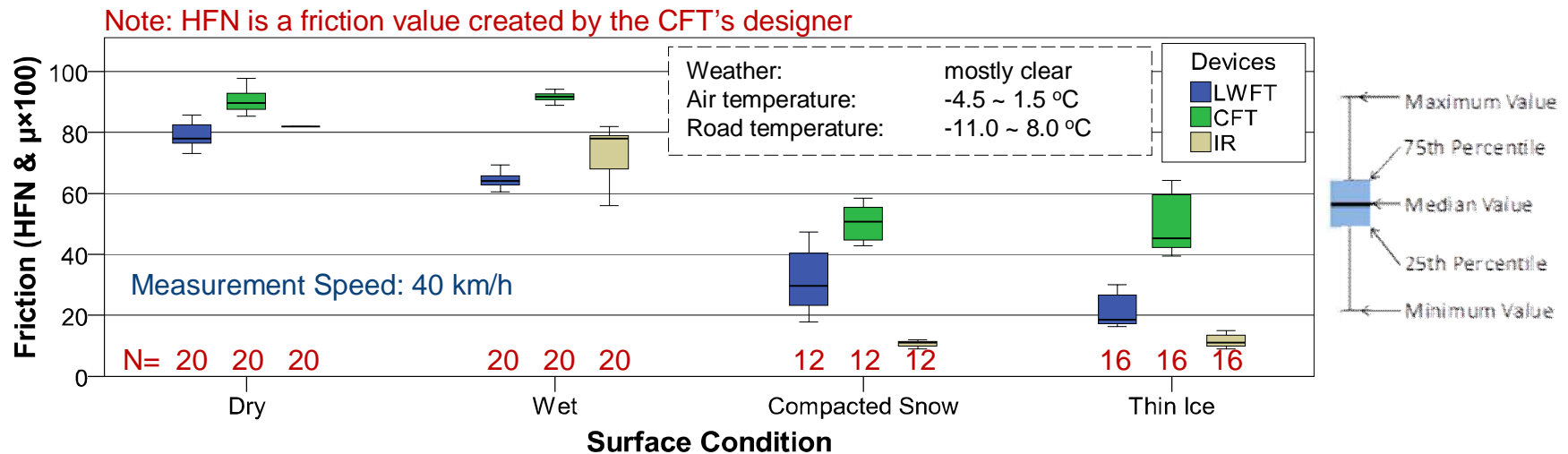
Road Surfaces Made on CERI's Test Track
(Tomakomai City)

- Testing speed
 - Test runs were performed at 20, 40, 60 and 80 km/h on each surface

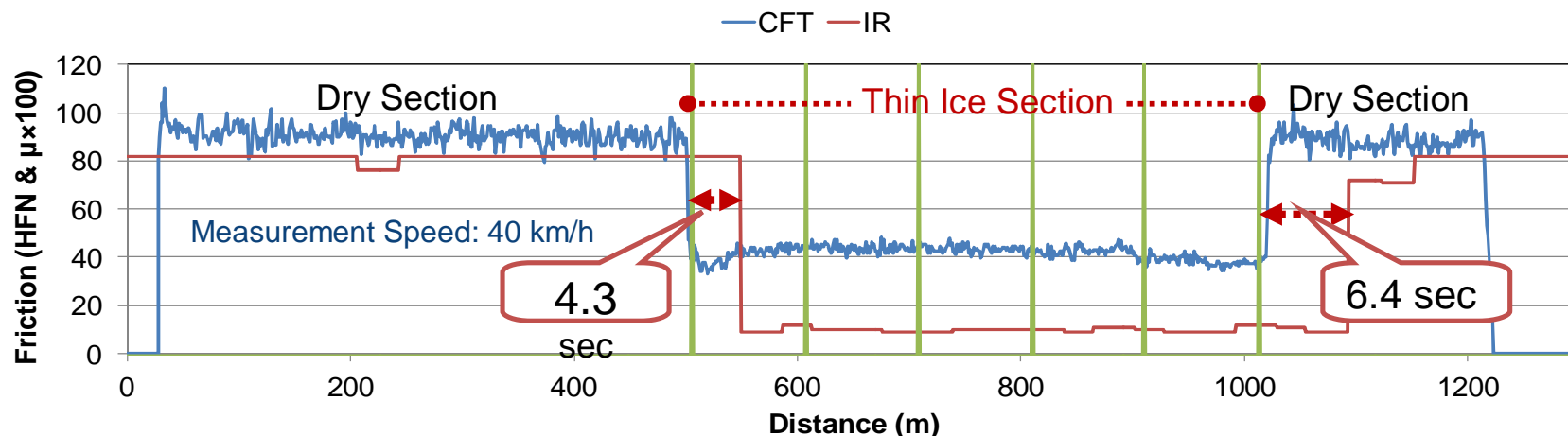
- Road Surface Types
 - Dry: fine-graded gap asphalt concrete pavement (clear)
 - Wet: 0.5 ~ 1.0 mm thick of water on the pavement
 - Compacted Snow: approx. 15 cm thick of compacted snow on the pavement
 - Thin-Ice: 0.5 ~ 1.0 mm thick of ice film on the pavement



Comparison Tests (Results)



Box plot of friction values according to surface conditions (Jan 22nd & 28th 2013)

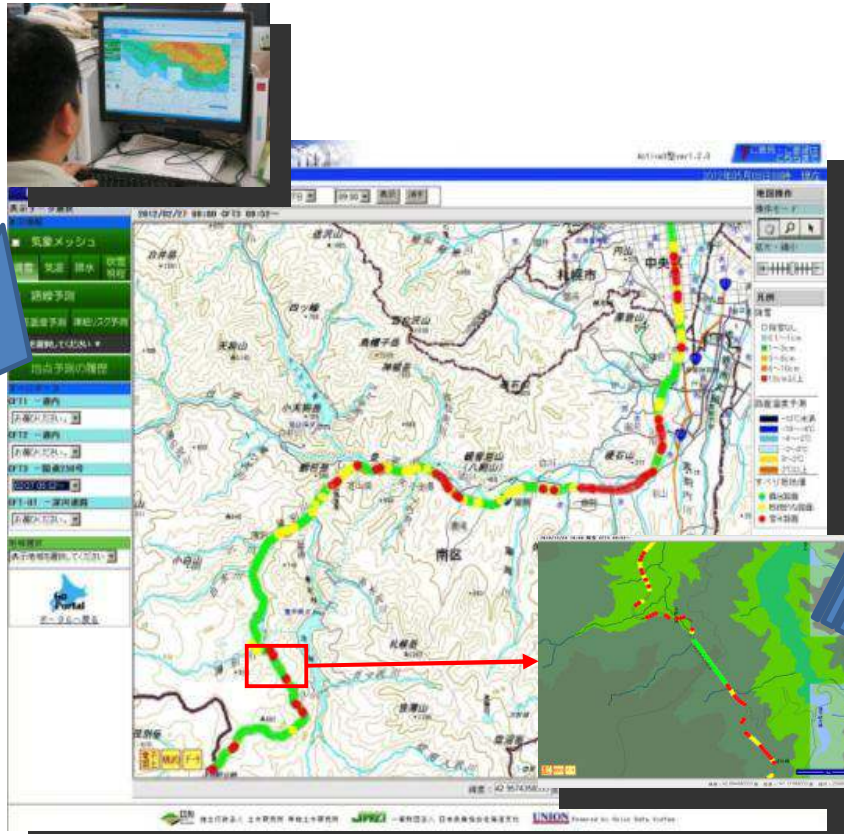


IR's time lags in the friction value changes in comparison with CFT (Jan 22nd 2013)

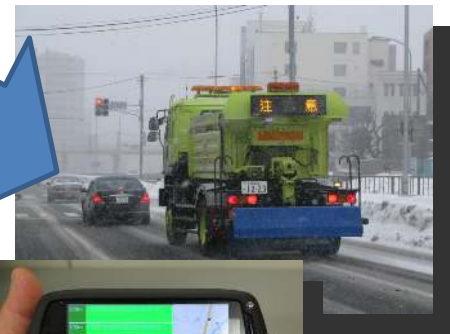
Using Friction Values (Decision Support Sys.)



Real time friction values can be used to check road surface condition during patrol

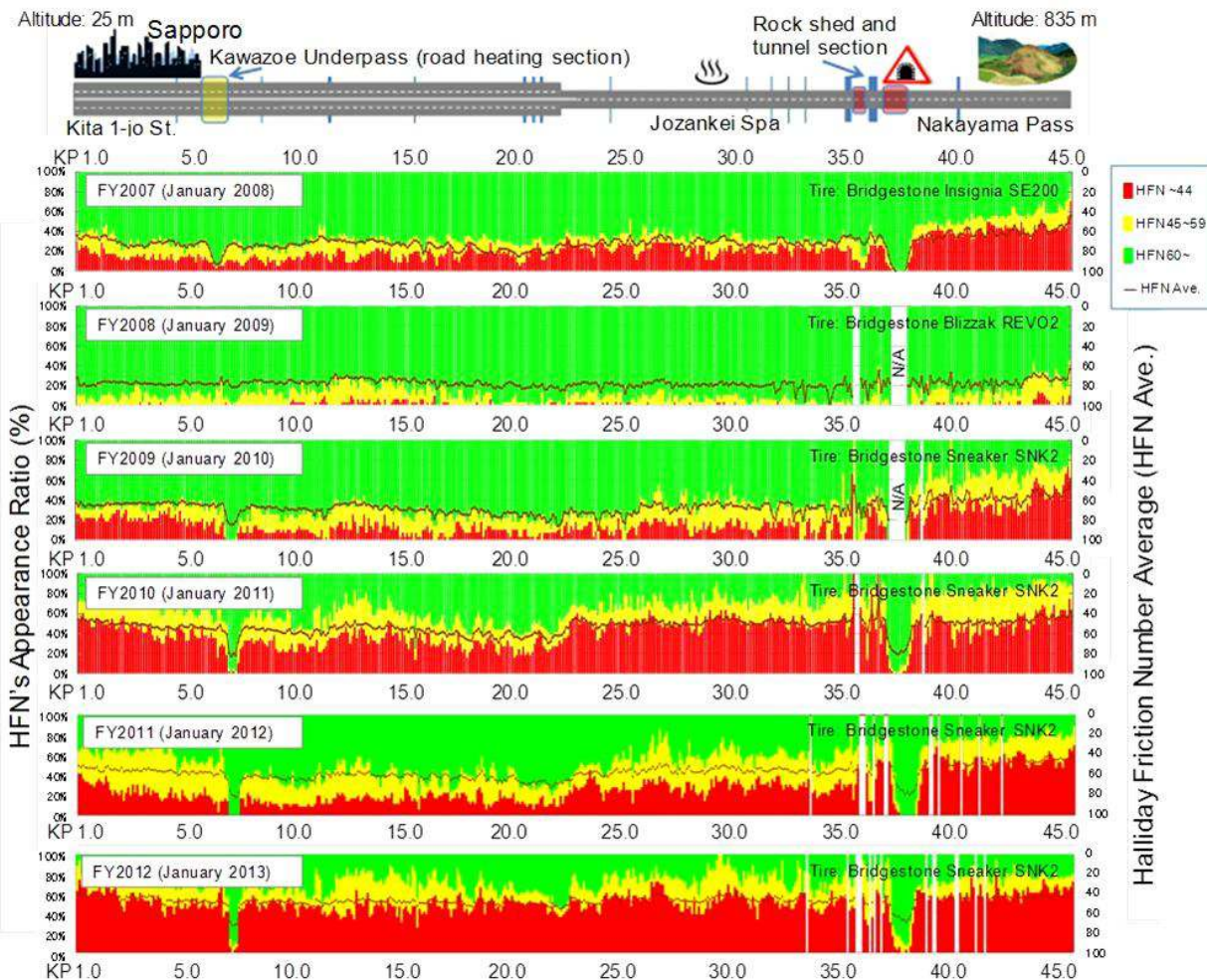


Road weather information and road surface condition information can be checked at the office

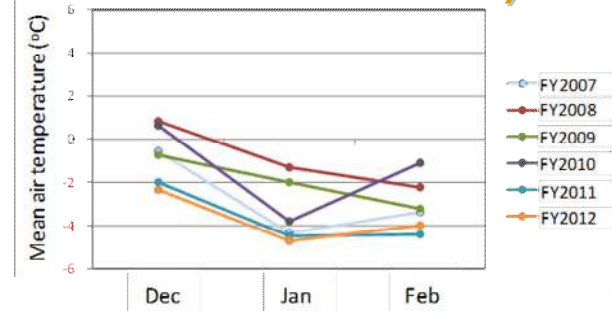


Friction data provided to operators on the spreader truck

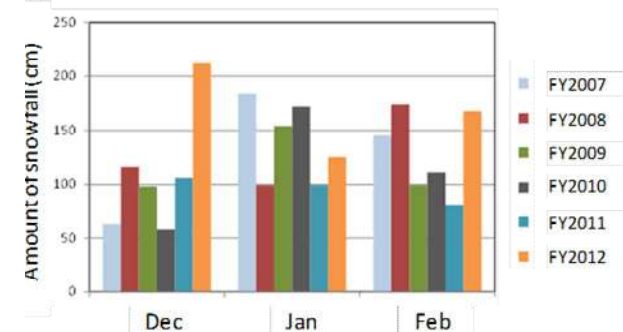
Using Friction Values (Performance Evaluation)



Appearance ratio of road surface conditions and HFN values on NH230 (January, 2008~2013)



Mean air temperature of Sapporo



Cumulative snowfall of Sapporo

NH230's maintenance operation

	Frequency of snow removal (January)			Saltspreading days (January)
	Primary	Leveling	Widening	
FY2007	80	90	75	18
FY2008	63	141	99	15
FY2009	65	151	82	14
FY2010	89	45	29	18
FY2011	75	96	47	30
FY2012	82	115	43	31

Summary & Future Prospects

- In order to propose efficient winter road service in view of the recent financial constraints in Japan and characteristics of snowy cold regions, the authors in this study conducted research on reports from various countries regarding the criteria for winter road surface management, methods for quantitative assessment of winter road surface, and utilization of friction values for supporting decision-making and feedback
- The authors will keep working on the improvement of technologies for forecasting road surface and weather conditions as well as for providing friction monitoring data to the managers and operators
- Also, a feedback tool will be developed to support performance evaluation of winter road service and decision-making on long-term road management to be used not only for identifying road sections that need special attention but also for feeding back information regarding usability of road surface management criteria in other road sections

Thank you for your attention!
¡Gracias por su atención!
Any Question?
¿Preguntas?

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