RPUG-PDRG 1st Joint Meeting
Knowledge Exchange for Pavement Diagnosis Innovation
Sapporo, Japan, April 19, 2019

Field Experiment for Accuracy Verification of Roughness Measuring Devices in TRUE Project

by
Kazuya Tomiyama (Kitami Institute of Technology, Japan)
Hiroyuki Mashito (Toa Road Corporation, Japan)
Shuich Kameyama (Hokkaido University of Science)
Hiroyasu Nakamura (NIPPO Corporation, Japan)

Contents

1. Introduction
2. Overview of the TRUE Project
3. Experiment Results
4. Recent Works
5. Summary

Road Surface Situations in Japan

- A lot of aged pavements
- Shortage of budgets for maintenance and rehabilitation
- Retirement of experienced engineers

Specific Strategy in Japan

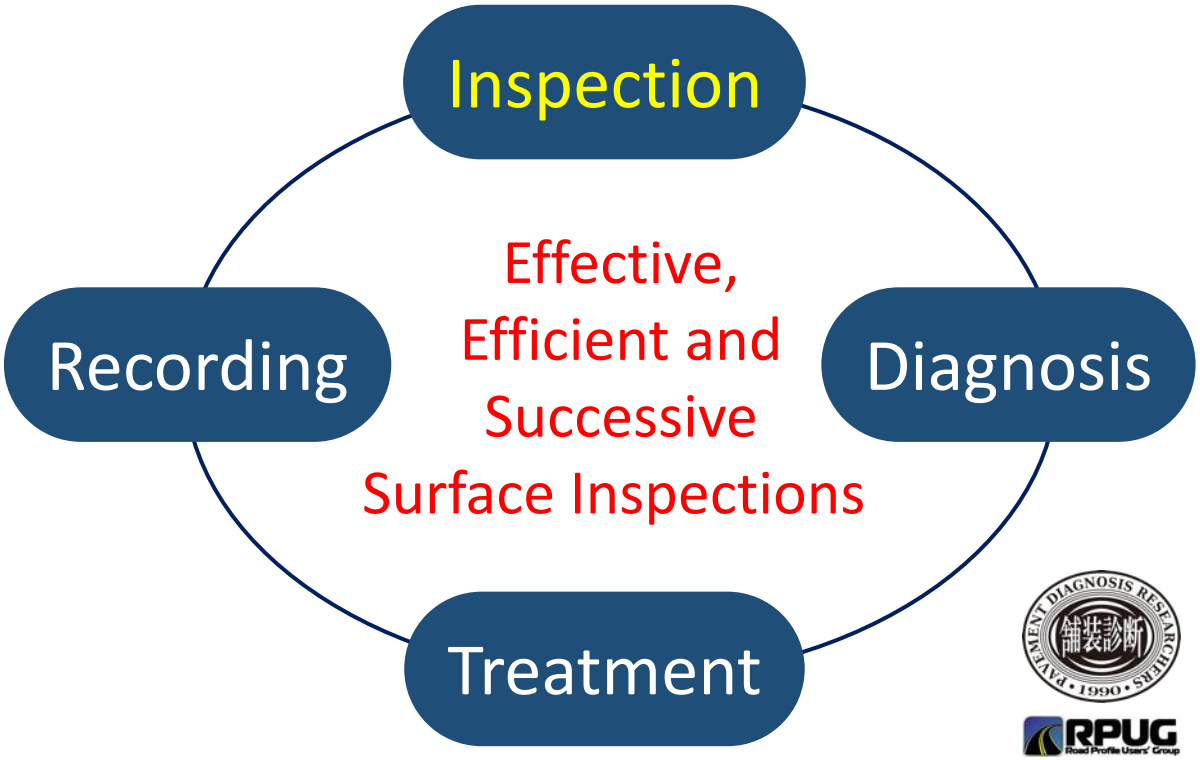
舗装点検要領
Pavement Inspection Manual

平成２８年１０月
国土交通省　道路局

October, 2016
BPR, MLIT

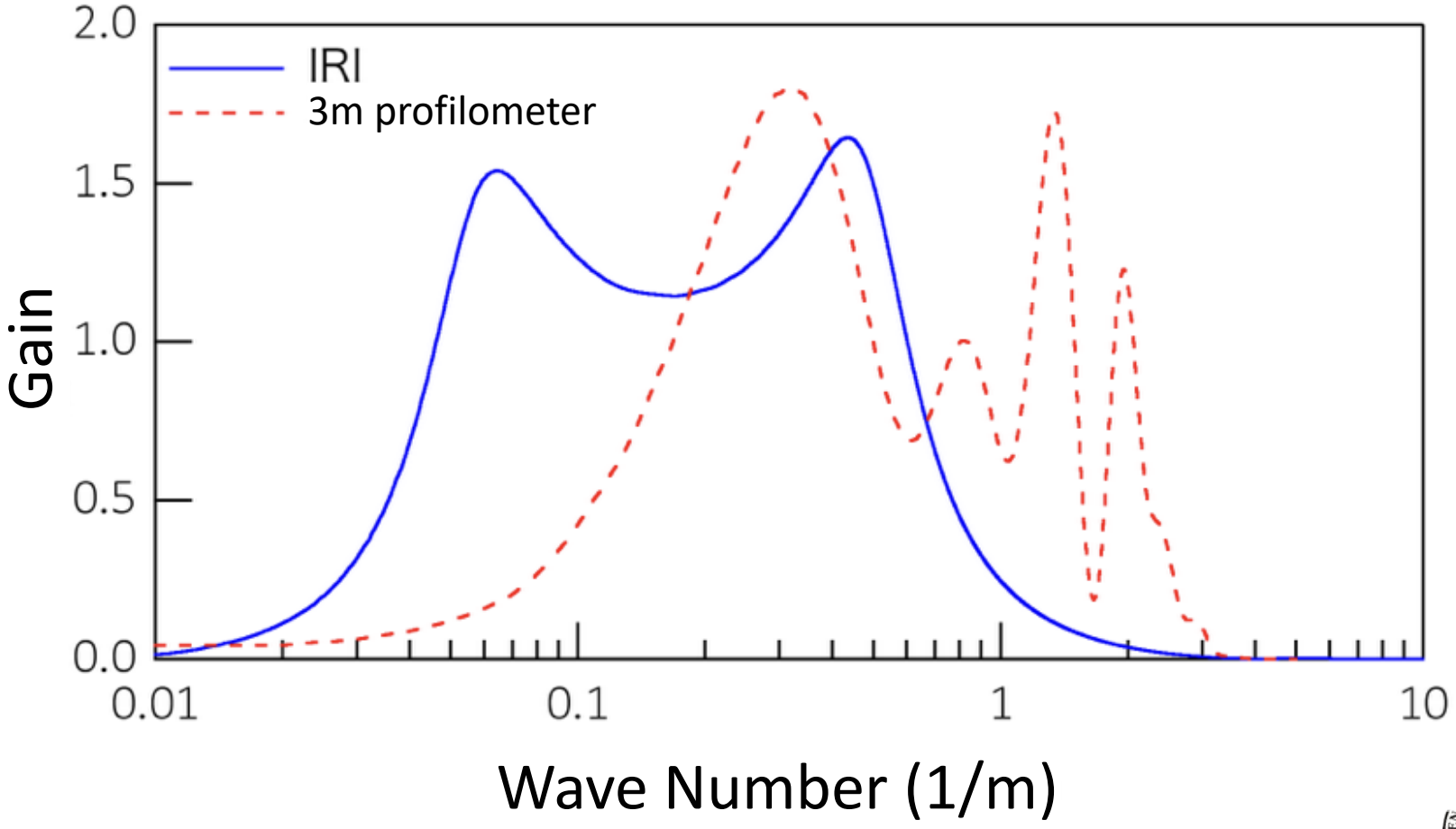
The Bureau of Public Road has issued...
Pavement Inspection Manual (2016)

- introducing ***IRI***
- to improve a ***Maintenance Cycle***



Why do We Use IRI ?

Response of Indices



Acceleration of Profiler Development

Class 1

- Rod and Level
- Static Dipstick

Class 3

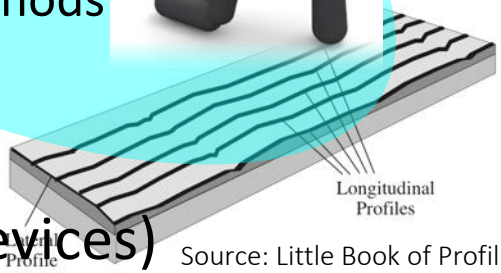
- RTRRMSs
- Smartphone Devices

Class 2

- High-speed Inertial Profilers

Class 4

- Visual Inspection
- Subjective Methods



Source: Little Book of Profiling

Brief History

1998 PIARC EVEN in Japan (7 devices)

⋮

2014 PDRG TRUE Project 1st Experiment (34 devices)

⋮

2016 PDRG TRUE Project 2nd Experiment (28 devices)

⋮

2018 PDRG TRUE Project 3rd Experiment (28 devices)

TRUE Project

Harmonize and Compare Test Methods for Surface Roughness Under Actual Road Environment

performed by a subcommittee of the committee on surface roughness characteristics in the PDRG

The Mission and Policy of TRUE Project

Improving Technologies of Surface Measurement Devices under Actual Road Environment by

- supporting the experiment operations
- analyzing the data obtained in experiments
- reporting and publishing the outcomes of activities

Features

- involving both high- and low-speed devices
  -> enhancing introduction and development of new devices
- conducting the experiments not only on highway but also local roads -> fit for the purposes

History of TRUE Project

Pre-experiment
Establish the reference measures (PWRI)

Draft Guideline for Pavement Inspection (2013)

• Accuracy Overview

TRUE 2014
(1st Exp. Sep. 2014)

FWD and GPR Survey 2014

Pavement Inspection Manual (2016)

• Overseas Participation
• Extra Test Section

TRUE 2016
(2nd Exp. Sep. 2016)

FWD Survey 2016

Pavement Management Guidebook based on the Pavement Inspection Manual (2018)

• Accuracy Report
• Device Groping

TRUE 2018
(3rd Exp. Oct. 2018)

FWD Survey 2018

- High quality reference profiles and open data for intercomparison
- Meeting engineers and exchange information

History of TRUE Project

Test Sites

The experiments were conducted on prefectural roads with the cooperation of Hokkaido prefecture of Japan.

- 200 m long with 20 m and 5 m additional extents
- including arterial and residential roads

Summary of Test Sites

Site	Section	Road Class	Length (m)	IRI (mm/m) for 200 m		
				FY 2014	FY 2016	FY2018
1	Section 1-1	Arterial	200	2.6	2.6	2.8
	Section 1-2			1.8	1.8	1.8
	Section 1-3 *			N/A	2.4	N/A
2	Section 2-1	Residential		6.3	6.5	6.7
	Section 2-2			4.5	4.5	4.7

* Section 1-3 was measured only in the second experiment in 2016

Participated Devices

Number of the Participated Devices

	FY 2014	FY 2016	FY2018	Total
High-Speed Devices	20	15	12	47
Low-speed Devices	14	13	16	43
Total	34	28	28	90

Inertial Profiler

Walking Profiler

MMS

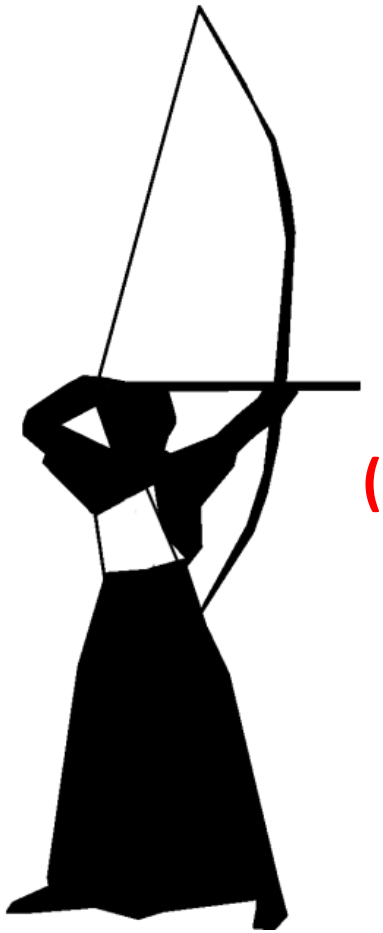
Low-speed Profiler

Data Recording and Reporting

Test Site	 Arterial Road	 Residential Road
Driving Speed	40, 50, 60 km/h	20, 30, 40 km/h
Num. of Rept.	3	
IRI	.xlsx; 10 and 200 m fixed interval	
Profile	.csv; possible minimum longitudinal sampling interval	

Analysis Method

Schematic Description



Systematic Error

Random Error

Good ← Bias → Poor

(Portability)

Good

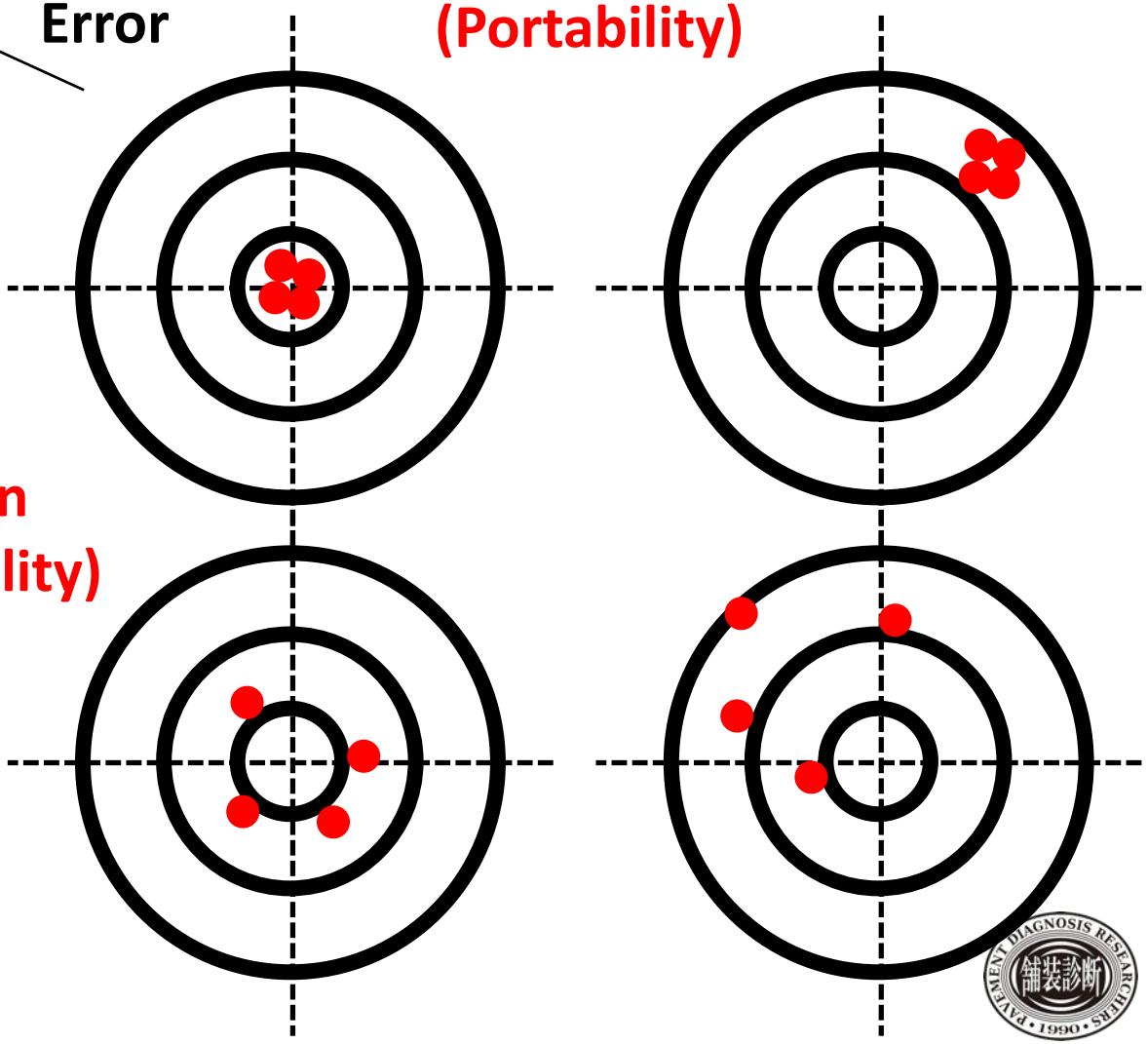
↑

Precision

(Repeatability)

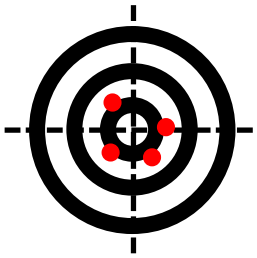
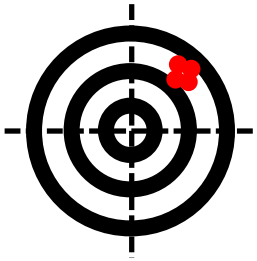
↓

Poor



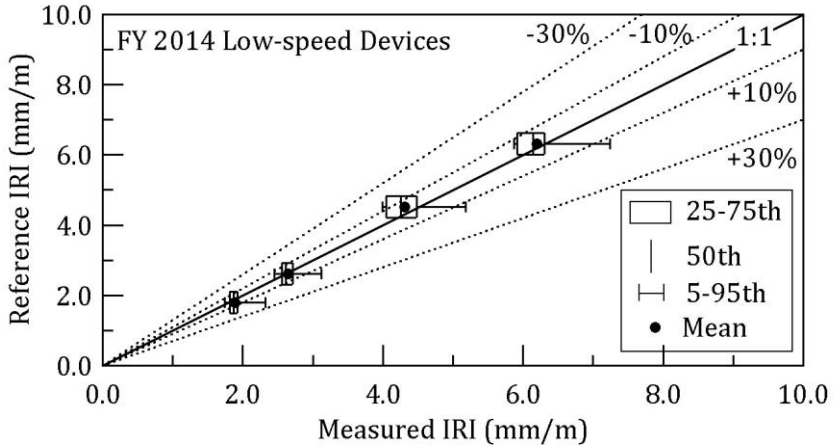
Analysis Method

Detailed Description

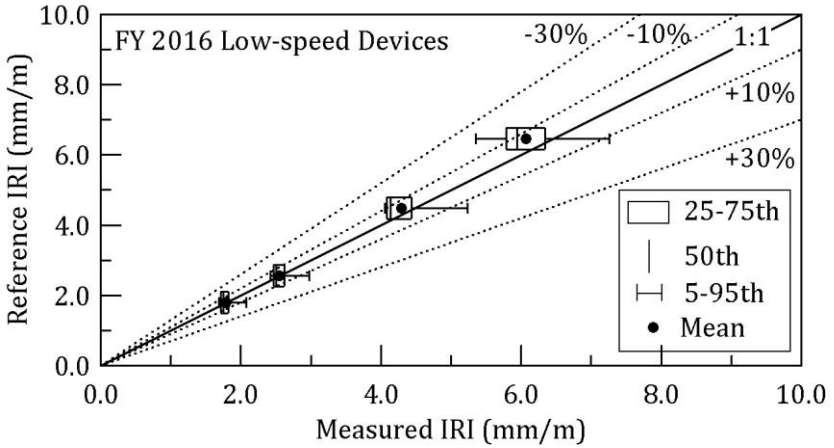
	Error	Factor	Description
Repeatability (Precision)	**Random** An ability to repeat the measures with a same profiler	**Within** Deviation from the average obtained with repeated runs	
Reproducibility and Portability (Bias)	Systematic An ability to repeat the measures with a different profiler	Between Deviation from the average obtained with an expected value	
Influence of Speed (only for high-speed devices)	Systematic An ability to repeat the measures on different operation speeds	Within Deviation from the average obtained with repeated runs	

Overview of Experiment Result

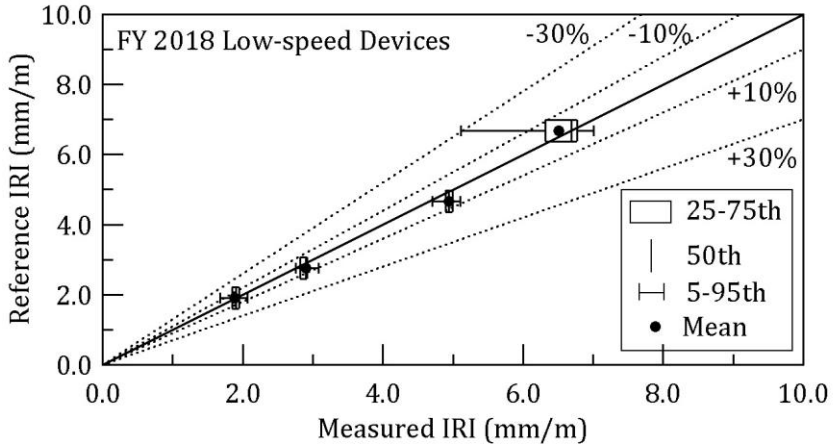
Low-Speed Profilers



FY2014



FY2016

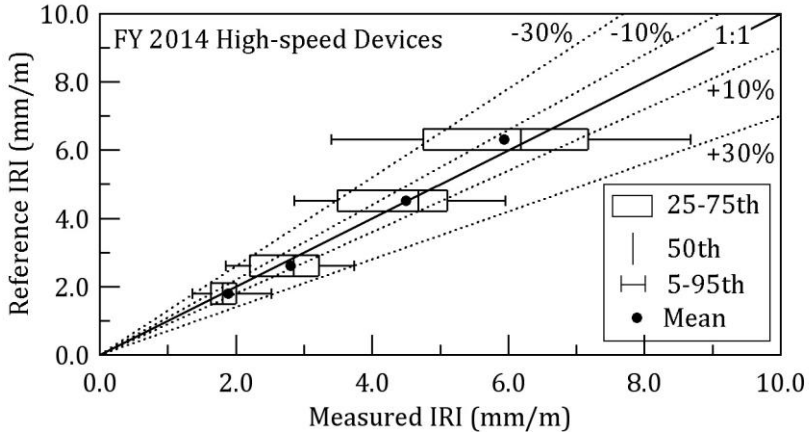


FY2018

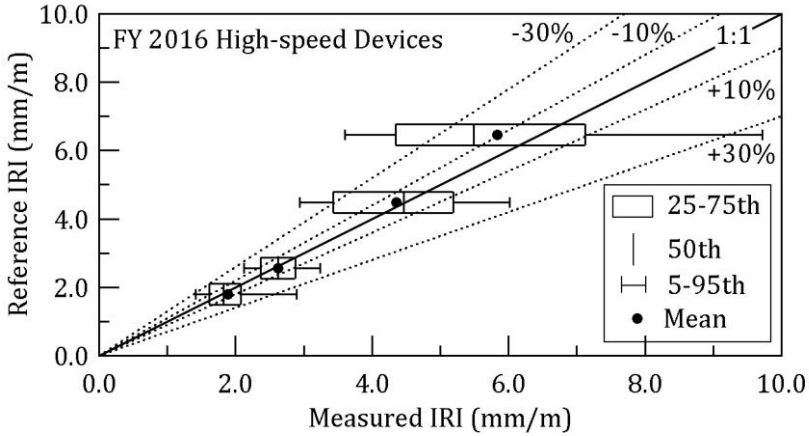
Within 10 %
on the 25th-75th percentile

Overview of Experiment Result

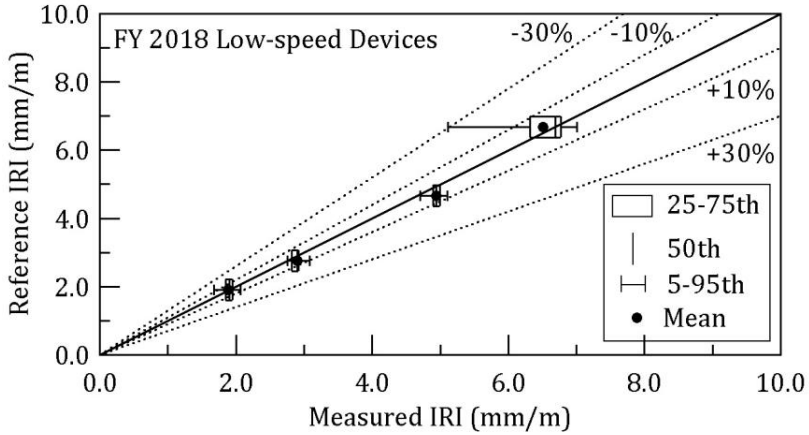
High-Speed Profilers



FY2014



FY2016



FY2018

FY2014/FY2016
Within 10 %
on the 50th-75th percentile

FY2018
Within 10 %
on the 25th-75th percentile

Device Grouping (Since 2018)

Group		Requirement					Profiler Class
I	A	Subjective	Visual insp. / Ride exp.		On Vehicle		Class 4
	B		Visual Inspection		By Walk		
II	A	Profile-based Method	Static		Measuring Elevation Directly*1		Class 1
	B				Measuring Elevation by inclinometer*2		
III	A		Dynamic	Low-Speed	Non-contact*3		Class 2
	B1				Contact*4	Dedicated Device	
	B2					Multi-purpose Device*5	
IV	A			High-Speed	Non-contact*3		
	B1				Contact*4	Dedicated Device	
	B2					Multi-purpose Device*5	
V	A	Response Type			Non-contact*3		Class 3
	B1				Contact*4	Dedicated Device	
	B2					Multi-purpose Device*5	
VI	-	Otherwise					-

*1 e.g. Rod and Level, *2 e.g. Dipstick, *3 Laser Sensor(s), *4 Wheel(s), *5 Smartphone Device(s)

Accuracy Report (Since 2018)

TRUE PROJECT 2018 EVALUATION REPORT

BASIC INFORMATION

General Information

Test Site		(Device Overview)
Date		
Device		
Vehicle Type		
Car Number		
Owner		
Operator(s)		

Measured Item(s)

Longitudinal Profile		Device Group	
International Roughness Index			
Operating Speed			

Measurement Conditions

Sampling Interval of Profiles		
Resampling	Yes / No	
IRI Reporting Interval		

EXPERIMENT RESULTS

Profile Agreement (Wavelengths between 0.5 m and 50 m)

Speed (km/h)	Run 1	Run 2	Run 3	Mean ± Standard Deviation

IRI (Fixed Interval of 200 m; mm/m)

Speed (km/h)	Run 1	Run 2	Run 3	Mean ± Standard Deviation

The above mentioned results are cerified in the TRUE Project 2018.

February 14, 2019

Pavement Diagnosis Researchers Group

APPENDIX

IRI (Fixed Interval of 10 m; mm/m)

BP	EP	True IRI	Speed 1			Speed 2			Speed 3		
			Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
0	10										
10	20										
20	30										
30	40										
40	50										
50	60										
60	70										
70	80										
80	90										
90	100										
100	110										
110	120										
120	130										
130	140										
140	150										
150	160										
160	170										
170	180										
180	190										
190	200										

SPECIAL NOTES

Summary

PDRG TRUE Project

- Harmonize and Compare Test Methods for Surface Roughness Under Actual Road Environment
- Experiments were conducted at Hokkaido, Japan in 2014, 2016 and 2018
- Not all of the devices used in Japan, but a number of them have been involved in this Project.

Analysis of Experiment Results

- Influence of operating speed for high-speed devices
- Repeatability
- Reproducibility and Portability

Summary

Additional Data

- Structural Properties were measured immediately after the experiments.
  - FWD (Falling Weight Deflectometer)
  - GPR (Ground Penetrating Radar)

  Relationship between functional and structural properties?

Questions?

Contact:
Kazuya Tomiyama, Dr. Eng.
Associate Professor
Kitami Institute of Technology
tomiyama@mail.kitami-it.ac.jp