PROFILER CERTIFICATION USING THE AASHTO R56 PROCEDURE

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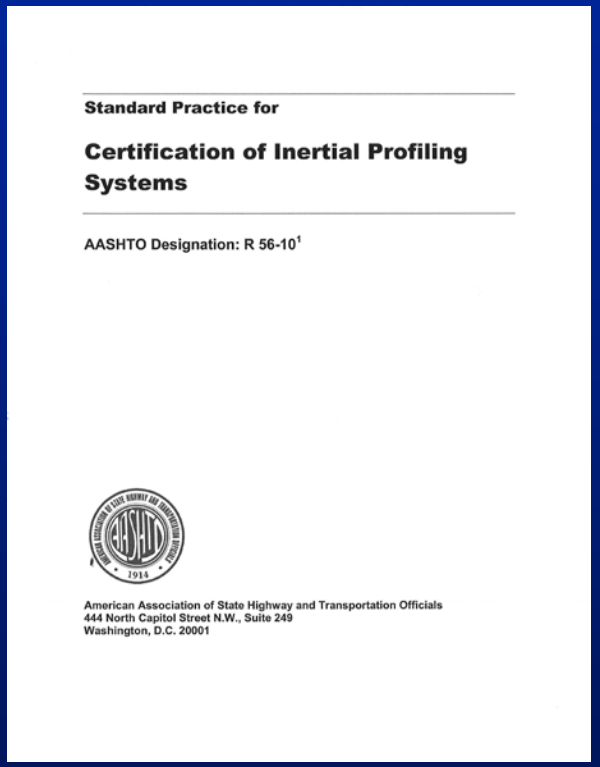
AASHTO R56, Certification of Inertial Profiling Systems

- Focused for profilers used for construction quality control also applicable for network profilers.
- Cross correlation of IRI filter output to:
  - Evaluate repeatability and accuracy of a profiler.



Standard Practice for

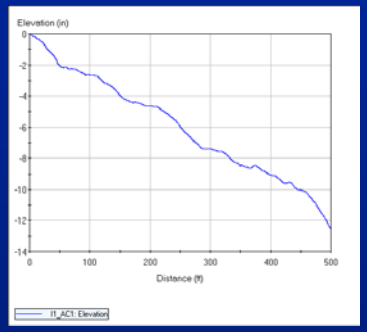
Certification of Inertial Profiling Systems

AASHTO Designation: R 56-10[1]

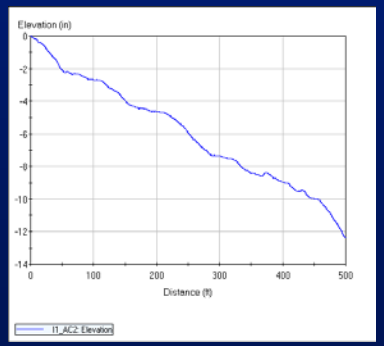
American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

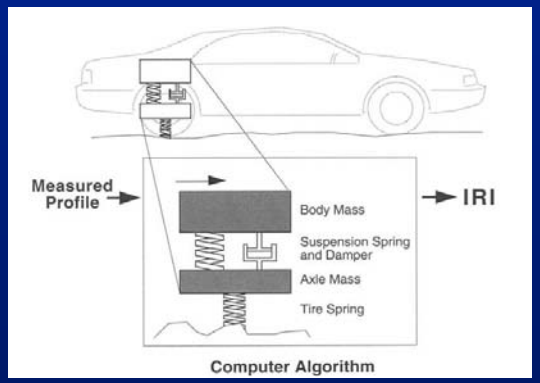
Cross Correlation

Profile 1

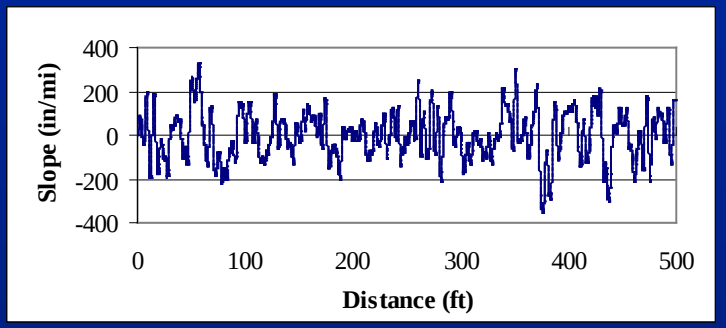


Profile 2

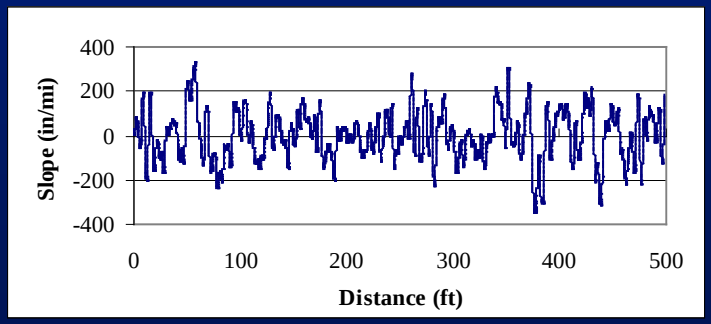




IRI Filtered Profile 1



IRI Filtered Profile 2



AASHTO R56 Requirements

- Profiler repeatability cross correlation (IRI filtered) ≥ 92%.
  - Ten profiler runs.
  - Cross correlate with each other and obtain average
- Profiler accuracy cross correlation (IRI filtered) ≥ 90%.
  - Ten profiler runs.
  - Cross correlate each profiler run with reference data and obtain average

SITE LAYOUT AND REFERENCE DATA COLLECTION

SurPRO

Able to obtain data at 1-inch interval at walking speeds

Site Layout and Mark Wheel Paths

Repeatability Cross Correlation – SurPRO 2000

Site	Surface	Runs	IRI (in/mi)		Repeatability CC (%)	
			Left	Right	Left	Right
MT - Site 1	AC	5	101	104	99	98
MT - Site 2	AC	5	115	137	99	97
CO - Site 1	AC	10	56	57	96	95
MA - Site 1	AC	6	77	79	94	95
MA - Site 2	AC	6	115	96	96	98
OH - Site 1	PCC	5	225	252	99	98
OH - Site 2	PCC	5	146	159	98	97

Effect of Site Markings – SurPRO Repeatability

Site	Runs	IRI (in/mi)		Repeatability CC (%)	
		Left	Right	Left	Right
Not Well Marked	5	62	60	93	91
Well Marked	5	63	58	96	94

PROFILER REPEATABILITY

Lightweight Profiler – MN/Road 2007

Site	Runs	IRI (in/mi)	Repeatability CC (%)
Asphalt	5	89	99.0
Concrete	5	77	99.1

RoLine Sensors

DOT-1 Data

Profiler	Driver	Average Cross-Correlation (%) Repeatability	
		Left WP	Right WP
1	1	95	94
	2	95	95
2	1	**91**	**91**
	2	95	96
3	1	94	95
	2	96	96
4	1	**91**	92
	2	95	94
5	1	95	94
	2	94	95

All Profilers Same Make, Single Spot Lasers.

AC Surface, IRI Left = 101 in/mi, IRI Right = 104 in/mi

DOT-2 Data

- 986 ft long section.
  - 550 ft asphalt concrete
  - 486 ft concrete

Direction	IRI (in/mi)	
	Left	Right
Northbound	135	155
Southbound	104	108

DOT-2 Data – 986 ft Long Section

Profiler	Sensor	Repeatability Cross Correlation (%)			
		Northbound		Southbound	
		Left	Right	Left	Right
Manufacturer 1	Single Spot	98	99	96	97
Manufacturer 2	Single Spot	98	98	94	93
Manufacturer 3	Infra Red	98	97	98	96
Manufacturer 4	Single Spot	97	97	92	93

DOT-2 Data for Asphalt Section (550 ft)

Profiler	Sensor	Repeatability Cross Correlation (%)	
		Left	Right
Manufacturer 1	Single Spot	98	99
Manufacturer 2	Single Spot	92	97
Manufacturer 3	Infra Red	94	93
Manufacturer 4	Single Spot	94	96
IRI (in/mi)		71	90

Smooth Sections

Site	Runs	IRI (in/mi)		Repeatability CC (%)	
		Left	Right	Left	Right
Asphalt-1	9	30	29	88	86
Asphalt-2	9	70	69	93	94

- Same profiler profiled the two sections.
- Profiler had a wide-spot laser 0.5 wide.
- Can the AASHTO spec be met on very smooth surfaces?

PROFILER ACCURACY

MN/Road Study 2007

Surface	IRI	Profiler Accuracy Cross Correlation (%)			
	(in/mi)	ARRB	Wide Tire	SurPRO	Surpro
		WP	Surpro	ICC	WI
Asphalt	90	94	98	98	98
Concrete	77	96	99	98	97

Transversely Tined Concrete

RoLine Sensors

Effect of Filtering

- High-Pass Filter R-56: Accurately measure wavelengths up to 150 ft. Minimum 30% reduction in profile amplitude for wavelengths > 300 ft, minimum 70% reduction for wavelengths > 450 ft.
- Evaluated profiler stored raw data, and had ability to generate a profile subjected to a 300 ft upper wavelength filter as well as an unfiltered profile.

Effect of Filtering

Wheelpath	SurPRO	Accuracy Cross Correlation with SurPRO	
	IRI (in/mi)	300 ft Butterworth Applied to Profile Data	No Filter to Profiler Data
Left	46	89	93
Right	59	85	96

Profiler Data	IRI (in/mi)	
	Left	Right
Without Filtering	46.4	59.9
With 300 ft Filter	46.7	60.1

Filter causes profiler to not meet the AASHTO Spec!

Effect of DMI Error

Case	Error in 500 ft (ft)	Profiler Cross Correlation With SurPRO (%)
No Profiler DMI Error	0	95.6
DMI Error 0.1%	0.5	94.4
DMI Error 0.15%	0.75	93.5
DMI Error 0.25%	1.25	91.2

It is Important to have an accurately calibrated DMI

Smooth Surfaces

Device	IRI (in/mi)	
	Left	Right
SurPro	32	28
Profiler	30	29

Profiler Repeatability Cross Correlation (%)	
Left	Right
88	86

Profiler Accuracy Cross Correlation with SurPRO (%)	
Left	Right
70	75

Profiler Obtained an Accuracy Cross Correlation of 90% at Another Site

Can AASHTO Requirement be met on Very Smooth Surfaces?

Conclusions

- Obtain repeat runs with reference device and check repeatability cross correlation.
- Profilers are generally capable of obtaining 92% repeatability cross correlation criterion.
- Problems with high pass filter in profiler can affect accuracy cross correlation .
- DMI errors will reduce accuracy cross correlation.

Conclusions

- **Profilers may have difficulty in meeting AASHTO requirements on very smooth surfaces (IRI about 30 in/mi or less).**