## Review of TxDOT Ride Specification Development and Implementation

WASHTO Meeting San Antonio, Texas March 2015



Presenter: Emmanuel Fernando

	2003	Item 585 (ride specification approved for 2004 Texas standards)
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	_	
	2002	SS 5880/5440 (ride specifications based on inertial profiler)
	-	
	-	
	2000	New ride spec/test method introduced in DE/DH meeting in Austin; Ride/Rut facility became operational
	-	
g	-	99 5591/5310 (profilegraph energifications based on null blanking band)
D	1999 -	33 339 733 TO (promograph specifications based on holi blanking band)
	1996	TxDOT conducts profile equipment rodeo
	-	
	-	
	1995	TxDOT develops prototype golf-cart mounted profiler
	-	
	-	
	1993	Item 585 (profilograph specification based on 0.20-inch blanking band)



# **TxDOT Ride Specifications**

- Ride quality assurance tests conducted by certified operators running certified inertial profilers.
- Test profiles used to determine pay adjustments based on IRI and need for corrective work.
- Correct IRI deficient sections (IRI > 95 in/mile) and defects (bumps and dips).



### Where We Were





# Where We Were

- Ride quality assurance tests done with the profilograph.
- Measurements done on both wheel paths to compute profilograph index based on 0.2-inch blanking band.
- Concerns raised that blanking band was masking out short wavelength roughness.





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## **Evaluation of Relationships between PI and IRI**







# **Goodness-of-Fit**







# **Goodness-of-Fit**





# **Summary of Findings**

- PI<sub>0</sub> correlates better with IRI than PI<sub>0.2</sub>
- PI<sub>0</sub> useful as an interim specification
- TxDOT released a null blanking band specification (SS 5591/5310)



# **Reasons for Changing**

# Public demand for smooth roads

# Cradle to grave statistic



# **Evaluation of Surface Profilers**





# "Walk-Along" Profilers



![](_page_18_Picture_2.jpeg)

![](_page_19_Figure_0.jpeg)

#### **Takeaways from Profiler Testing**

 Inertial profilers available to implement profile-based ride specification

 Recommendations for profiler certification

![](_page_20_Picture_3.jpeg)

#### **TxDOT's Certification Program**

# Provide 3<sup>rd</sup> party independent verification

# Certification of TxDOT profilers Broaden range of test sections

![](_page_21_Picture_3.jpeg)

#### Dense-Graded HMA Test Track

620

![](_page_22_Picture_1.jpeg)

#### **CRCP** Test Track

#### Flexible Pavement Test Track

![](_page_23_Picture_2.jpeg)

![](_page_24_Picture_0.jpeg)

# CRCP Test Sections

![](_page_24_Picture_4.jpeg)

6

![](_page_24_Picture_5.jpeg)

• Facility became operational in 2000 TxDOT Test Method Tex-1001-S for QA testing in Texas. • Option to test under AASHTO R56 Schedule of certifications Conducted tests for state DOTs, FHWA, and international consultants

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#### **Reference Profile Measurements**

![](_page_26_Picture_1.jpeg)

• Collect elevation readings at 1inch intervals using SurPRO.

- Tie SurPRO data to a common benchmark using rod and level measurements collected at 190-ft intervals.
- Make 3 repeat reference profile runs per wheel path.

![](_page_26_Picture_5.jpeg)

![](_page_27_Figure_0.jpeg)

![](_page_28_Figure_0.jpeg)

![](_page_29_Figure_0.jpeg)

![](_page_30_Figure_0.jpeg)

![](_page_31_Figure_0.jpeg)

![](_page_31_Picture_1.jpeg)

### **IRI Cross-Correlations**

M-L	В	С	M-R	В	С
A	100	99	A	99	99
В		99	В		99

### Medium-smooth from station 315 to 843

![](_page_32_Figure_3.jpeg)

Smooth from station 600 to 1128

![](_page_32_Picture_5.jpeg)

# **Profile Repeatability Check**

![](_page_33_Figure_1.jpeg)

Charts of 10 repeat runs from tests. Which profile is more repeatable?

![](_page_33_Figure_3.jpeg)

![](_page_33_Picture_4.jpeg)

### **Accuracy of Inertial Profilers**

- The profile from an inertial profiler does not look like the profile from a rod and level.
- Even so, the accuracy of inertial profilers may be evaluated using reference profiles.

![](_page_34_Picture_3.jpeg)

![](_page_35_Figure_0.jpeg)

![](_page_36_Figure_0.jpeg)

## **Profile Accuracy Check**

![](_page_37_Figure_1.jpeg)

Which profile is more accurate?

![](_page_37_Figure_3.jpeg)

![](_page_37_Picture_4.jpeg)

![](_page_38_Figure_0.jpeg)

![](_page_39_Figure_0.jpeg)

### **Certification Test Results**

![](_page_40_Picture_1.jpeg)

![](_page_40_Picture_2.jpeg)

### **Certification Test Results**

![](_page_41_Picture_1.jpeg)

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#### INERTIAL PROFILER CERTIFICATION TEST RESULTS

Profiler Operator:	Todd Copenhaver and Phillip Hempel		
Wheel path(s) tested:	Left and right wheel paths		
Surface type tested:	Dense-graded HMA		
Test date:	4/23/2014		
Test administered by:	E. Fernando and G. Harrison		
Inertial profiler model:	TxDOT VAMOS Profiler		
Inertial profiler serial #:	2903220H		
Inertial profiler VIN:	1FMNE31P96HA58571		
Laser type:	LMI/Selcom single-point lasers on both wheel paths		
Filter type:	Four-pole reverse filter		
Filter program:	Reference_profile_filterV1_2.Exe		
Version #:	November 8, 2012		
Overall test result	PASSED per TxDOT Test Method Tex-1001-S		

#### Table 1. Repeatability of Inertial Profile Measurements.

Section	Wheel Path	Average Standard Deviation (mils) <sup>1</sup>
Medium smooth	Left	12
Mediamismoodi	Right	11
Smooth	Left	11
Smooth	Right	10

<sup>3</sup> Not to exceed 35 mils per TxDOT Test Method Tex-1001-S

Table 2. Accuracy of Inertial Profile Measurements.			
Section	Wheel Path	Average Difference (mils) <sup>2</sup>	Average Absolute Difference (mils) <sup>3</sup>
Medium smooth	Left	3.64	18.30
Mediamismoodi	Right	4.03	18.43
Smooth	Left	-0.79	13.06
Smooth	Right	-0.97	10.28

<sup>2</sup> Must be within ±20 mils per TxDOT Test Method Tex-1001-S
<sup>3</sup> Not to exceed 60 mils per TxDOT Test Method Tex-1001-S

Page 1 of 2

![](_page_41_Picture_12.jpeg)

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#### Table 3. Repeatability of IRIs Calculated from Inertial Profile Measurements.

Section	Wheel Path	Standard Deviation (inches/mile) <sup>4</sup>
Section	Wheel Faul	Standard Deviation (menes/mile)
Medium smooth	Left	1.45
	Right	1.04
Smooth	Left	1.08
	Right	1.01

\* Not to exceed 3.0 inches/mile per TxDOT Test Method Tex-1001-S

#### Table 4. Accuracy of IRIs Calculated from Inertial Profile Measurements.

	Section	Wheel Path	Difference between Averages of Test and Reference IRIs (inches/mile) <sup>5</sup>	
	Medium smooth	Left	-0.44	
		Right	0.43	
	Smooth	Left	0.31	
		Right	2.61	

<sup>5</sup> Absolute difference not to exceed 6 inches/mile per TxDOT Test Method Tex-1001-S. Positive difference indicates higher IRIs from inertial profiler relative to reference IRIs.

![](_page_41_Picture_23.jpeg)

Page 2 of 2

#### Summary

- TxDOT began its inertial profiler certification program to support implementation of a ridespecification based on inertial profile measurements
- TxDOT developed an adaptation of ASTM E950 for its inertial profiler certification program, adding a requirement for IRI repeatability and IRI accuracy
- TxDOT's profiler certification program is continuing to evolve as the Department considers adapting new technology and standards developed in recent years

![](_page_42_Picture_4.jpeg)

# **Reasons for Changing**

- Public demand for smooth roads
- Cradle to grave statistic
- Better frequency response
- Ride perception dependent on frequency components of profile
- More accurate data

![](_page_43_Picture_6.jpeg)

# **Reasons for Changing**

- Greater productivity
- Profile data can be used to develop other indices
- Provide statistics that are stable with time, transportable
- Profile data correlated to true profile
- Allows smoothness to be built from the bottom up

![](_page_44_Picture_6.jpeg)

# Thank you for your attention! Comments or questions?

![](_page_45_Picture_1.jpeg)