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AASHTO V AUSTROADS PROFILER VALIDATION - SMACKDOWN

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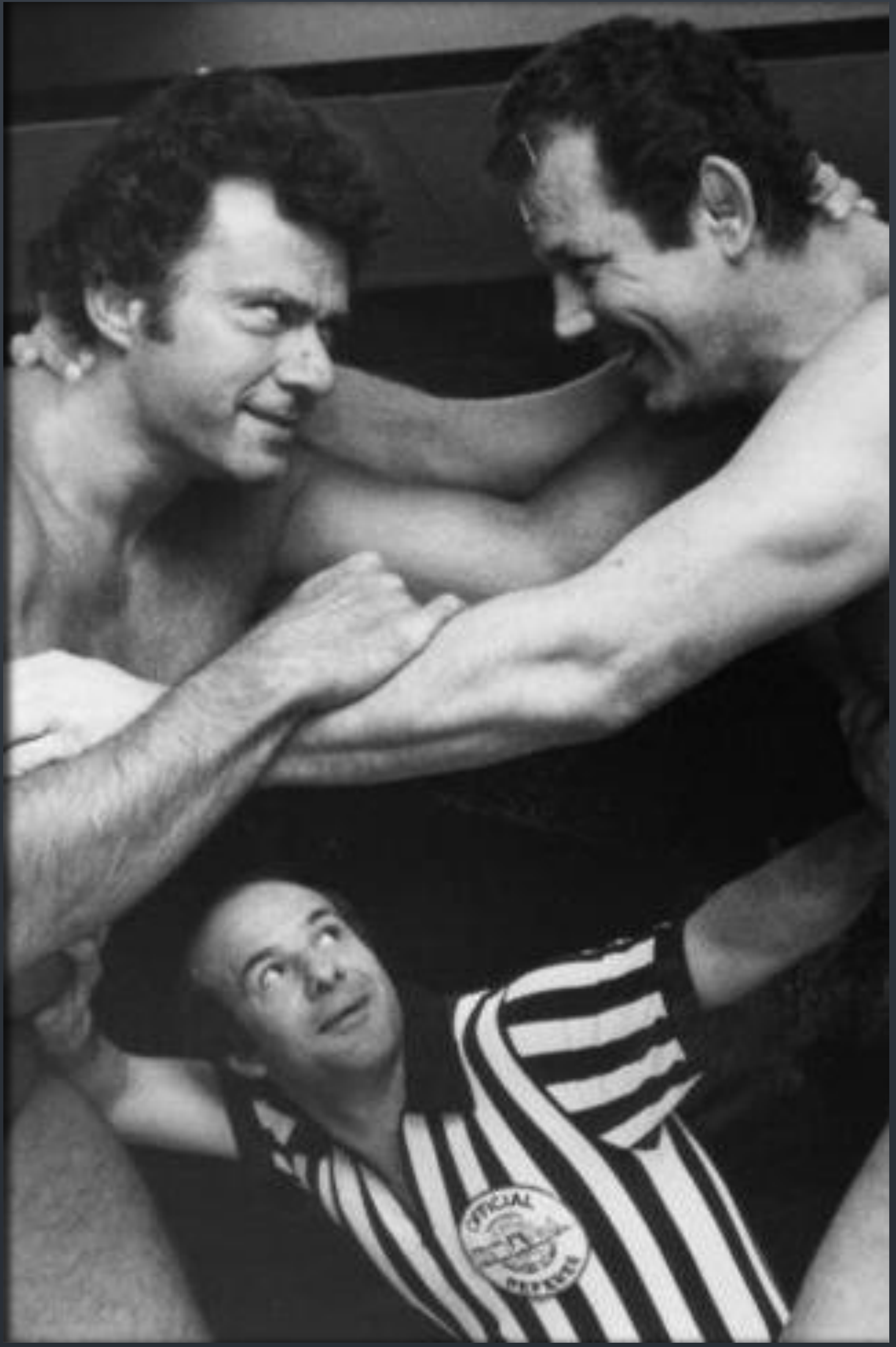
National Transport Research Organisation, Australia

2026 RPUG CONFERENCE ★ PITTSBURGH, PA ★ APRIL 28 - MAY 1


OFFICIAL


IRI vs IRI – WHO'S ROUGHER?
CHECK THE WAVELENGTH FILTERING!
PROFILER POWER!
AASHTO STANDARDS MANUAL
WHERE'S THE CALIBRATION CERTIFICATE?!
CRASH!
AUSTROADS ROUGHNESS STANDARD
IRI @ 80 km/h
AASHTO ROUGHNESS STANDARD
Quarter-Car Model
GRAPPLE!
PROFILER POWER!

LET'S GET READY TO RUMBLE

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NTRO NATIONAL TRANSPORT RESEARCH ORGANISATION

BACKGROUND

Since the mid-2000s, Australia has had a series of test methods for measuring & validating profilers

Asset Management		
Test Methods		
AGAM-T001-16	Pavement Roughness Measurement with an Inertial Profilometer	13/05/2016
AGAM-T002-16	Validation of an Inertial Laser Profilometer for Measuring Pavement Roughness (Reference Device Method)	13/05/2016
AGAM-T003-16	Validation of an Inertial Laser Profilometer for Measuring Pavement Roughness (Loop Method)	13/05/2016
AGAM-T004-16	Pavement Roughness Repeatability and Bias Checks for an Inertial Profilometer	13/05/2016

Austroads Test Methods and Specifications

In summary:

- 5x sites
- ≥500m in length
- specific roughness range
- 3x profiler speeds

5.2 Validation of Roughness Measurement

(a) Select five test sections of road pavement, each 500 m long, with the following characteristics:

- At least one 500 m test section must have an average IRI roughness of between 0.9 m/km and 1.6 m/km (based on roughness reported at 100 m), i.e. the average of the five 100 m segments must fall within these limits.
- Similarly, at least one section must have an average roughness of between 1.9 m/km and 3.1 m/km.
- Similarly, at least one section must have an average roughness of 3.4 m/km or greater.
- The remaining two sections must have average roughness values greater than 1 m/km and less than 7 m/km.
- At least two of the total 25 individual 100 m segments must have a roughness of 4.5 m/km or greater.
- Sections shall be selected so as to ensure that their surface characteristics (materials, texture, etc.) are representative of the road network(s) to be surveyed.
- Sections should be selected with sufficient lead-in to bring the inertial profilometer vehicle up to the highest test speed (test speeds are discussed in (c) below) at approach and sufficient length beyond the test site for safe operations.

7.2 Validation of Roughness Measurement

Report the following:

(a) the location of each section tested

(b) date and time of validation checks

(c) identification of inertial profilometer and base instruments used

(d) for each section and survey speed, the calculated IRI values for each wheelpath and the lane using both the inertial profilometer and the reference method

(e) for each of the three test speeds, the slope A, intercept B, and coefficient of determination, r^2, calculated in 6(b)

(f) for all of the results combined, the slope A, intercept B, and coefficient of determination, r^2, calculated in 6(c)

(g) a statement as to whether the inertial profilometer passes or fails validation of profile measurement – the inertial profilometer is considered to have passed the profile measurement validation if all the values reported in 6(b) and 6(c) fall within the following ranges:

(h) individual speeds (6(b)): $0.95 \le A \le 1.05$, $-0.25 \le B \le 0.25$ m/km, $r^2 \ge 0.95$

(i) combined results (6(c)): $0.95 \le A \le 1.05$, $-0.25 \le B \le 0.25$ m/km, $r^2 \ge 0.95$.

The validation limits in 7.2(g) cannot be used if the selected validation sites do not match the characteristics listed in 5.2(a).

Validation of an Inertial Laser Profilometer for Measuring Pavement Roughness (Reference Device Method)

Site 1

ROAD_ID	ROAD_NAME (SITE 1)	DESCRIPTION FROM	DESCRIPTION TO	SUBURB	TDIST_START	TDIST_END	TDist (KM)	START LAT	START LONG	END LAT	END LONG
484	EUMUNDI - KENILWORTH ROAD	DATH HENDERSON RD	OVERKANDERS SHOP	TINBEERWAH QLD 4563	0	0.498	0.498	-26.40145845	152.9590795	-26.40052457	152.9637586

Site 2

ROAD_ID	ROAD_NAME (SITE 2)	DESCRIPTION FROM	DESCRIPTION TO	SUBURB	TDIST_START	TDIST_END	TDist (KM)	START LAT	START LONG	END LAT	END LONG
484	EUMUNDI - KENILWORTH ROAD	257m EAST OF COLEUS RD	LARNEYS LANE	EERWAH VALE QLD 4562	0	0.603	0.603	-26.46821424	152.921472	-26.46808227	152.9155943

Site 3

ROAD_ID	ROAD_NAME (SITE 3)	DESCRIPTION FROM	DESCRIPTION TO	SUBURB	TDIST_START	TDIST_END	TDist (KM)	START LAT	START LONG	END LAT	END LONG
485	KENILWORTH - SKYRING CREEK ROAD	230M EAST OF WARRAGUL LANE	NEAR ROAD RESERVE	TUCHEKOI	0	0.597	0.597	-26.38297084	152.7521596	-26.38757527	152.7493004

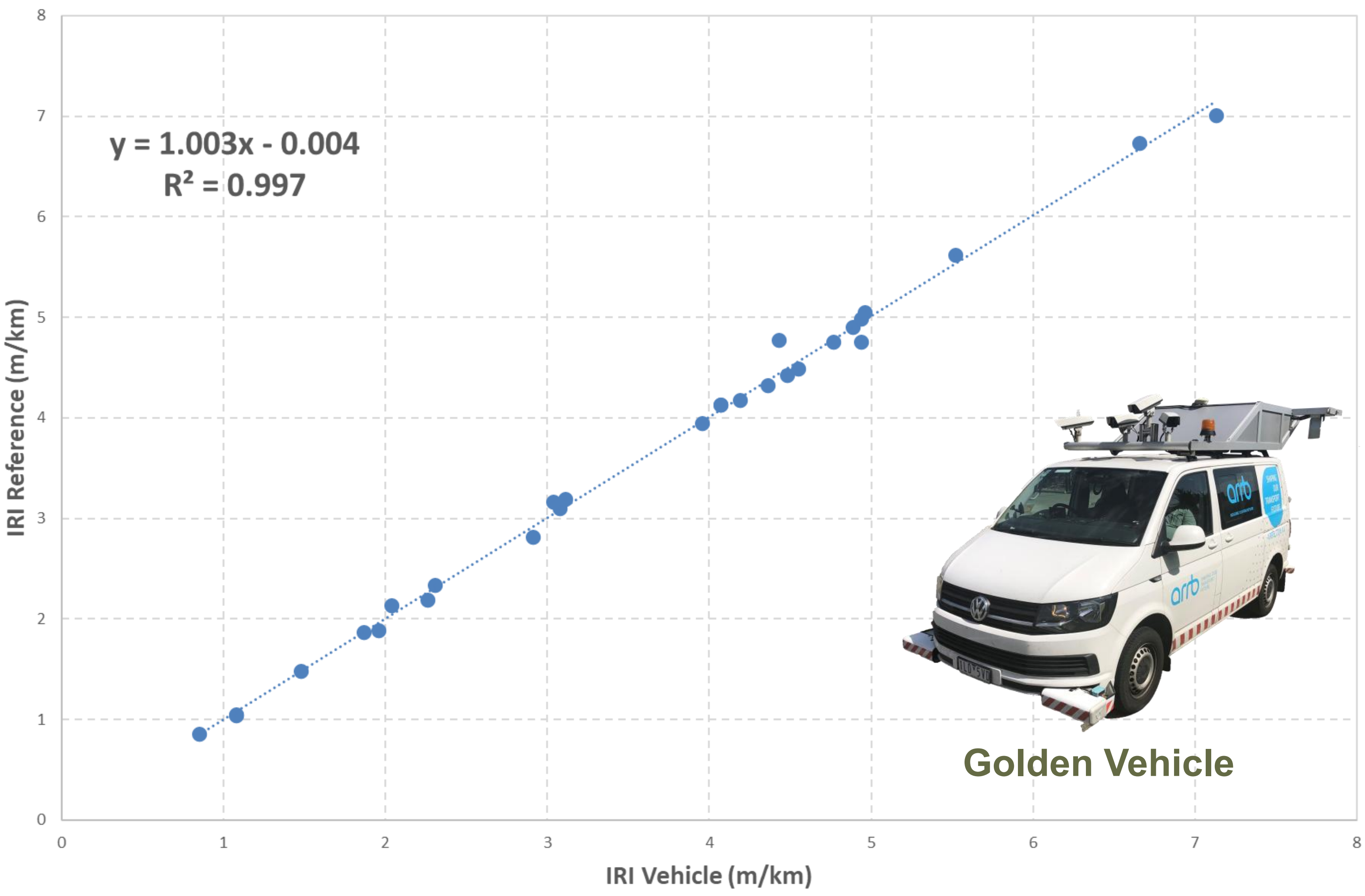
Site 4

ROAD_ID	ROAD_NAME (SITE 4)	DESCRIPTION FROM	DESCRIPTION TO	SUBURB	TDIST_START	TDIST_END	TDist (KM)	START LAT	START LONG	END LAT	END LONG
485	KENILWORTH - SKYRING CREEK ROAD	400m WEST OF HAPPY JACK CREEK RD	GILLILAND RD	CARTERS RIDGE QLD 4563	0	0.602	0.602	-26.45809238	152.7771241	-26.46145382	152.7826724

Site 5

ROAD_ID	ROAD_NAME (SITE 5)	DESCRIPTION FROM	DESCRIPTION TO	SUBURB	TDIST_START	TDIST_END	TDist (KM)	START LAT	START LONG	END LAT	END LONG
485	KENILWORTH - SKYRING CREEK ROAD	IRONSTONE CREEK RD	PROPERTY ENTRANCE	TUCHEKOI	0	0.5	0.5	-26.42424	152.75785	-26.4271	152.76198

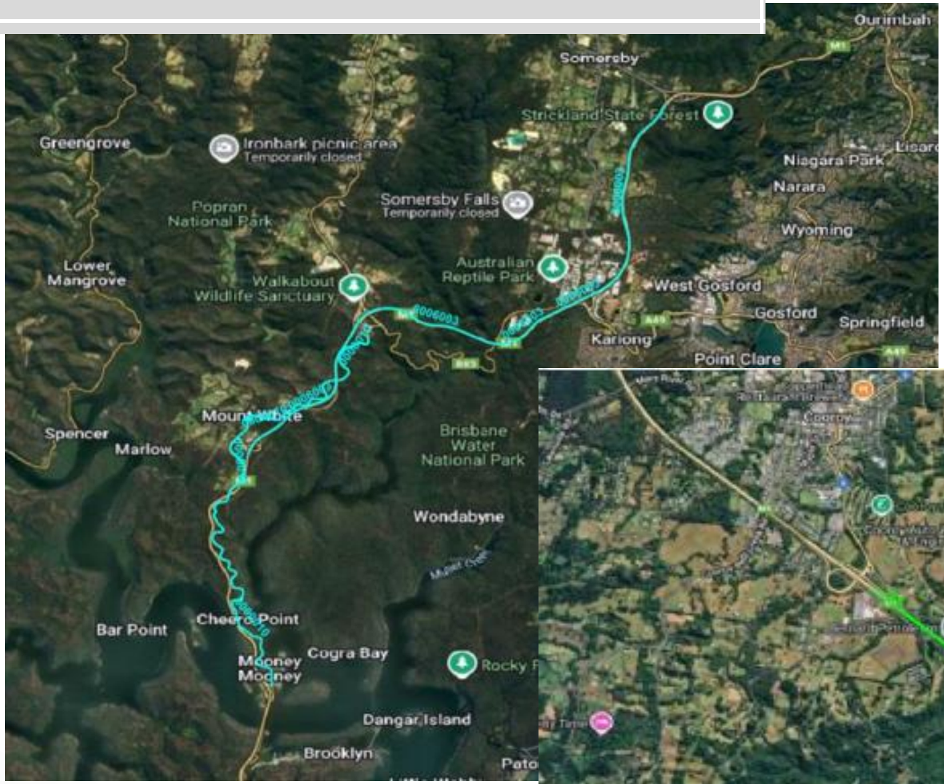
AGAM-T002-16	Validation of an Inertial Laser Profilometer for Measuring Pavement Roughness (Reference Device Method)



AGAM-T003-16	[Validation of an Inertial Laser Profilometer for Measuring Pavement Roughness (Loop Method)]

Certification loops

- New South Wales
- Queensland



QDTMR and TfNSW

Certification of Roughness Measurement Devices – Protocols and Process Manual

NTRO CERTIFICATION

AGAM-T003-16

Validation of an Inertial Laser Profilometer for Measuring Pavement Roughness (Loop Method)

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Laser Profiler Correlation

Supplier: CPBGGJV **Report No:** PR-002871-17

Profiler: AMES 8300 High Speed Profiler

Vehicle Registration [redacted] **Vehicle Description:** Toyota Prado

Driver: [redacted] **Operator:** [redacted]

The vehicle/crew combination as described above carried out the prescribed set of correlation runs on the TfNSW Roughness Calibration Sites situated between Mooney Mooney and the Somersby Interchange, north of Sydney on 28/03/2025.

These sites comprise two stretches of road covering the range of NAASRA Roughness Values from approximately 20 to 200. It also covers a range of road types from single lane winding road to full multi-lane freeway conditions.

The Supplier Laser Profiler made five (5) repeat runs and the results for each individual run were presented to NTRO, Data Analytics, for analysis. A mathematical correlation was performed on these results by comparing them individually, and as a whole, to the results obtained by the NTRO Reference Laser Profiler as per Test Method T187, Appendix A. The results of the correlation are as follows:

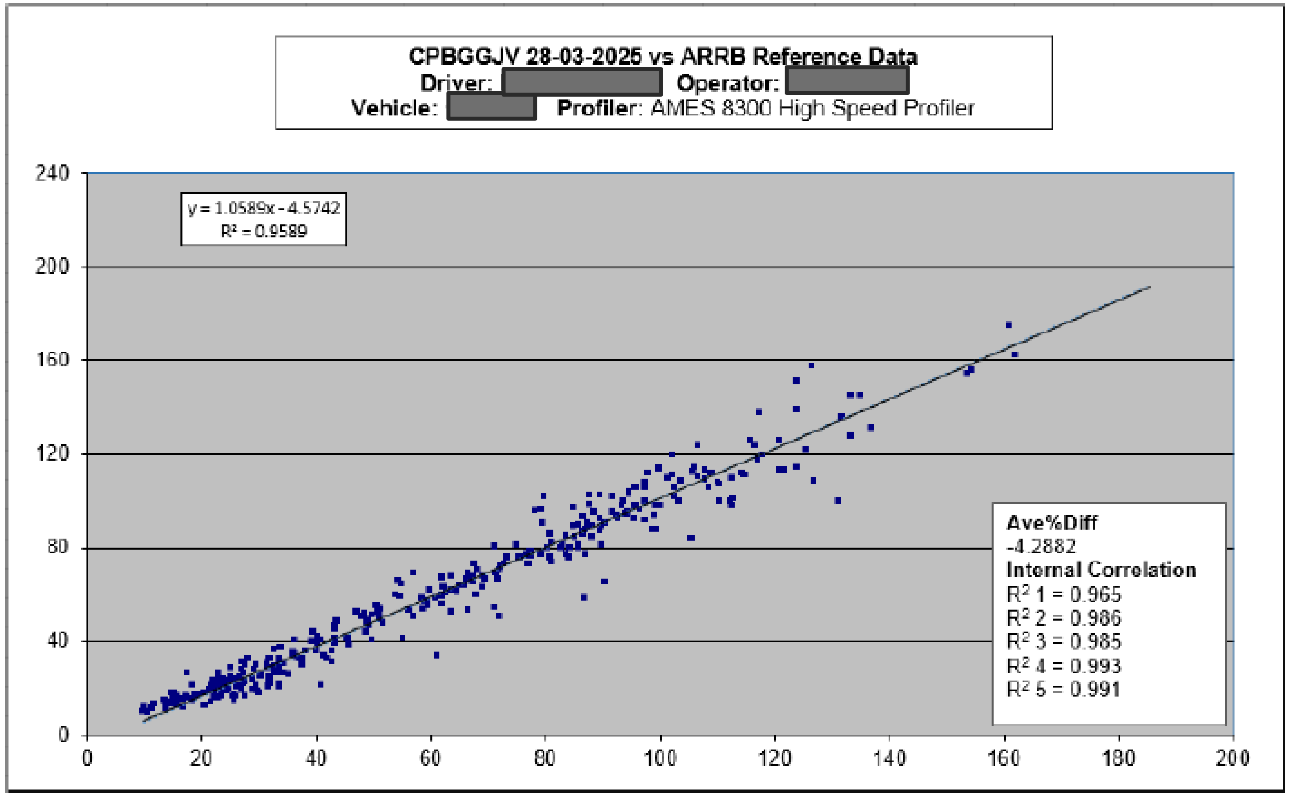
Overall Correlation	Slope:		1.0589
	Intercept:		-4.5742
	R Squared:		0.9589
	Average % Difference:		-4.2882
Internal Correlation:	Run 1	R Squared:	0.965
	Run 2	R Squared:	0.986
	Run 3	R Squared:	0.985
	Run 4	R Squared:	0.993
	Run 5	R Squared:	0.991
Average Speed:	F3:		107.6 kph
	HW10 (Pacific Hwy):		54.5 kph

These results represent a PASS on the R Squared and Average % difference for this vehicle/crew combination. (Discrepant results, if any, are indicated by an asterisk).

The above correlation results were derived solely from the data presented by the supplier. These results may not be applicable to other combinations of drivers and/or vehicles.

Shannon Malone
National Laboratory Leader,
Sustainability and Material Performance
4 April 2025

APPENDIX A: Comparison to Referance Data



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SO, WHO WINS THE RUMBLE?

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AGAM-T001 Pavement Roughness Measurement with an Inertial Profiler

- covers basic equipment specifications, operation and reporting requirements.

Versus

AASHTO M328 Standard Specification for Inertial Profiler

- defines required attributes of an inertial profiler.

AASHTO R43 Quantifying Roughness of Pavements

- describes a method for estimating roughness for a pavement section.

AASHTO R57 Operating Inertial Profiler Systems

- describes a procedure for operating and verifying the calibration of an inertial profiler system.

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LEVEL OF DETAIL

6.2 Operational Validation Procedure (Bounce Test)

The operational validation procedure, commonly known as the bounce test, is quick and easy to undertake, and provides a ready means of ensuring that the inertial profilometer equipment is behaving in the expected manner.

A base plate used for transducer calibrations should be used when performing a bounce test so as to minimise any roughness measurements that may be obtained due to surface unevenness.

(a) A manufacturer's operational validation test (bounce test) must be performed before the start of each day's testing (refer to manufacturer's user manual).

(b) This test verifies the correct operation of the laser displacement transducers, the accelerometers and their associated electronics. The test simulates a bouncing vehicle travelling along a completely flat surface. The measured profile should be zero, as movement of the vehicle is expected to be cancelled out by the accelerometers. However, due to electronic noise and other factors a negligible roughness value is usually recorded, i.e. less than 0.15 m/km.

(c) Throughout the bounce test, roughness readings greater than 0.15 m/km are unacceptable, and survey testing must not commence until the causes for the high reading have been identified and corrected.

X1. BOUNCE TEST PURPOSE, REASONING, AND ERROR

X1.1. A bounce test is a sanity check on the profiler to ensure that the data from the height sensor and accelerometer are legitimate and being properly combined to compute the longitudinal profile. While the host vehicle is stationary, an artificial signal is supplied to the profiler to simulate a travel speed within the manufacturer's recommended range (preferably midrange) for collecting road profile data. A routine data collection run is initiated, after which the suspension on the host vehicle is excited to cause the sensor(s) to move vertically. Since the sensor footprint is hovering over the same location, the end result, in theory, should be a perfectly flat and level road profile, the IRI of which would equal zero if all is working correctly. In practice, a perfectly flat profile with a zero IRI is not possible. Sources of error in a bounce test include:

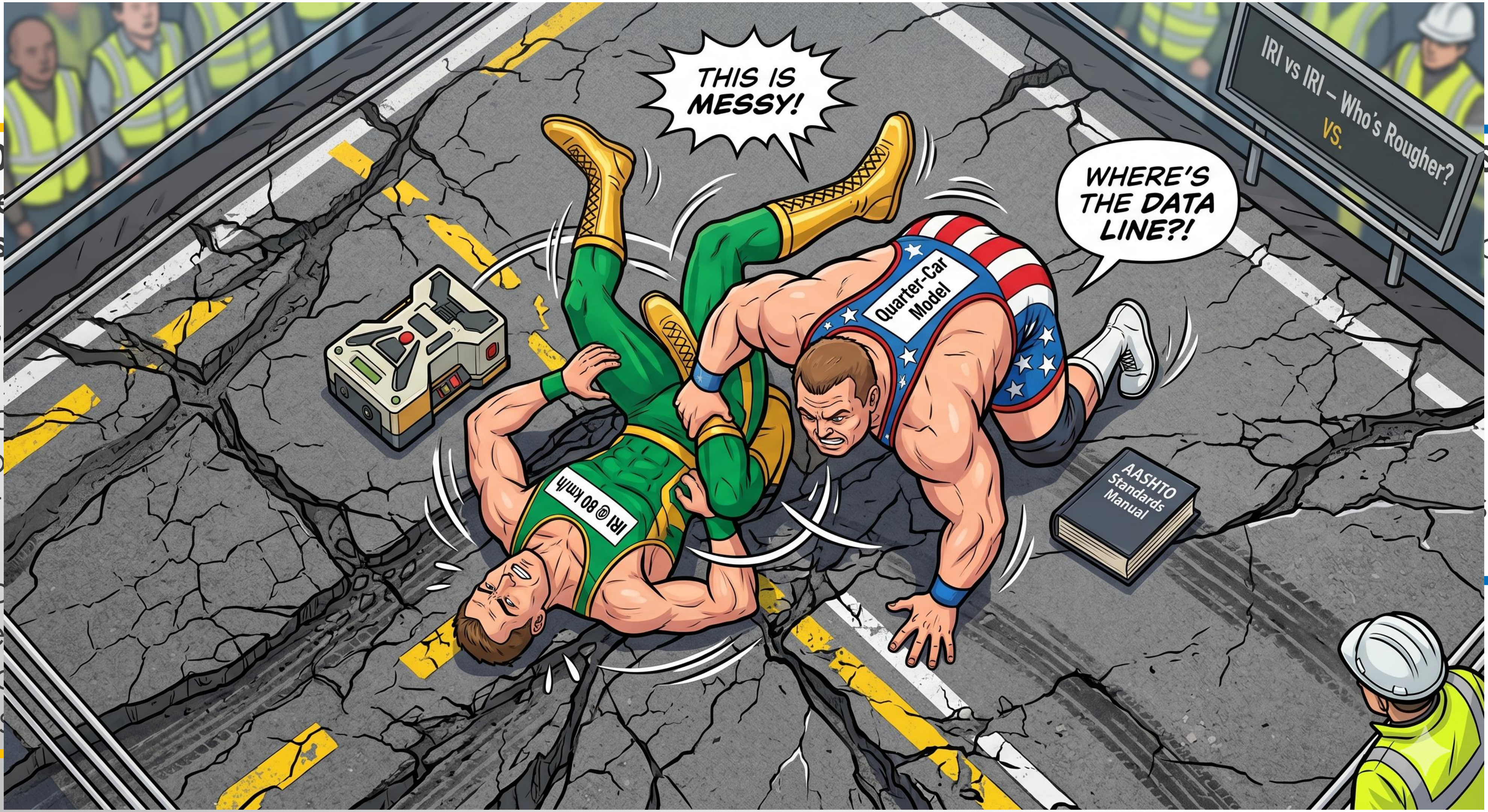
- Signal noise of the height sensor, accelerometer, and respective circuitry;
- Inability to position the host vehicle in such a manner that the sensors are perfectly perpendicular to a known flat and level surface;
- Inability to bounce the host vehicle such that sensors maintain a perpendicular orientation to the flat and level surface (sensor footprint moves laterally or fore and aft due to pitch and roll of the host vehicle while bouncing);
- Equipment malfunction;
- Error in signal and data processing;
- Accelerometer is mounted such that the axis of the accelerometer is not vertical;
- Height sensor and/or accelerometer are not properly secured; and
- Height sensor is not mounted at the proper elevation, which may result in the position of the sensor relative to the pavement surface exceeding the sensor's measurement range.

X1.2. There are two levels of acceptable error in both static (nonbounce) and bounce profiles in which a minimum of 528 ft of simulated longitudinal distance is traveled. The limits of IRI of those profiles are 3 in./mile and 8 in./mile, respectively.

SO, WHO WINS THE RUMBLE?

AGAM-T00
Profilomete
Roughness
PROS
- long tes
- large ro
- stricter c
- 3 test sp
- 5 test sit

CONS
- based c
  linear re
- less prec
- high cos



Systems
d level
low

LOCAL ISSUES

- longitudinal tinning
- small profile pool
- certification/validation is not always compulsory

Photo courtesy of ‘the’ man who needs no introduction

ADOPTING R56, WHAT'S THE PROBLEM?

We lack the following:

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CONCLUSION

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THANKS

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