Introduction of Pavement Smoothness Measurement

Flexible Pavement Committee Meeting
7-24-25
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Overview

Contents:

1. Laser Profiler (IRI & RN)
2. Rolling Straightedge (RSE)
3. The Difference Between These Methods
4. General Cases / Common Situations

Pavement Smoothness Measurement Index

- **International Roughness Index (IRI)**
- **Ride Number (RN)**

Standard pavement roughness index to measure the pavement ride quality (smoothness & roughness) of pavement surface

* FDOT data collection is governed by FM5-549 for collection of pavement data using a laser profiler.

Pavement Smoothness Measurement Index

What is IRI?

- Measure how smooth or rough a road is.
- Simulate how a car would react driving over the surface at traffic speed.
- The lower the IRI (unit: inch/mile), the smoother the ride.
- Federal standard and used widely in other states.

What is RN?

- Describe how smooth the ride feels, using a scale from 0 to 5.
- The higher the RN, the better the ride.
- The RN is more sensitive to shorter wavelengths than the IRI.

Laser Profiler Measurement

Both IRI and RN are measured using a **laser profiler vehicle**

High Speed Inertial Profiler

Bumper mounted laser sensors on each wheel-path measure distance to the ground to determine the longitudinal profile.

International Roughness Index (IRI) – Specification*

How does IRI work?

An incentive/disincentive for ride quality

LOT IRI Value	LOT Pay Adjustment
< 43	Incentive: +$20 /IRI value for each 0.1-mile LOT
43-55	Full Pay
55 - 95	Disincentive: -$20 /IRI value for each 0.1-mile LOT
> 95	Remove & Replace

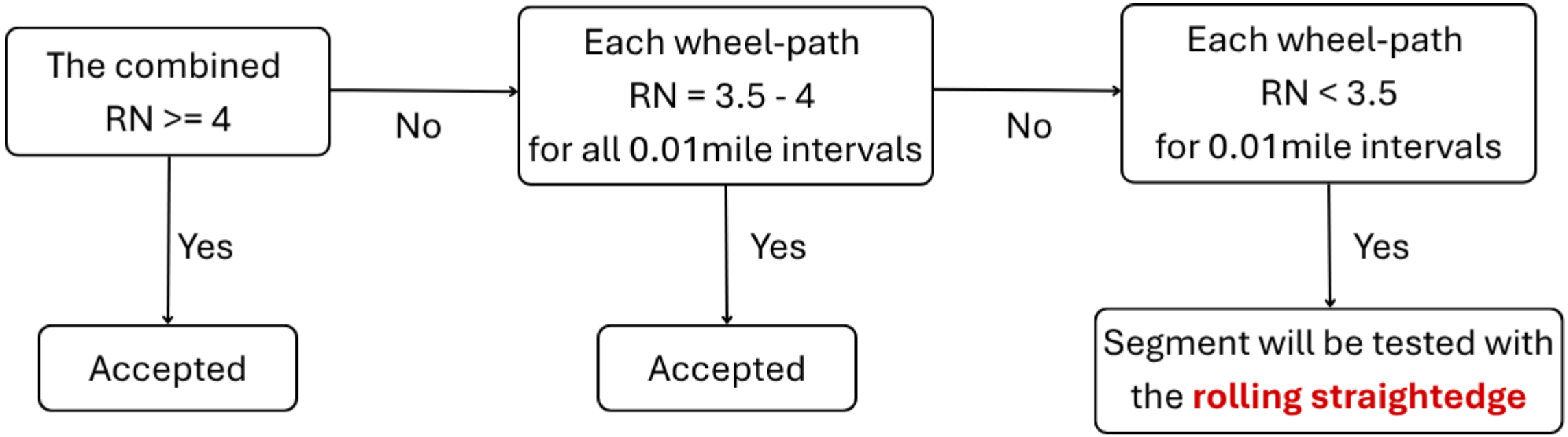
- LOTs IRI > 95 can be left in place, with max disincentive of -$800 per 0.1-mile LOT, based on district engineers' decision.

* Florida Limited Access Pavements

Ride Number (RN) – Specification

How does RN work?

- LOTs are typically 0.1-mile/0.01-mile segments



Rolling Straightedge (RSE) Overview

The rolling straightedge can be used to measures the maximum **deviation** of the pavement surface from straight reference line.

How is RSE measured?

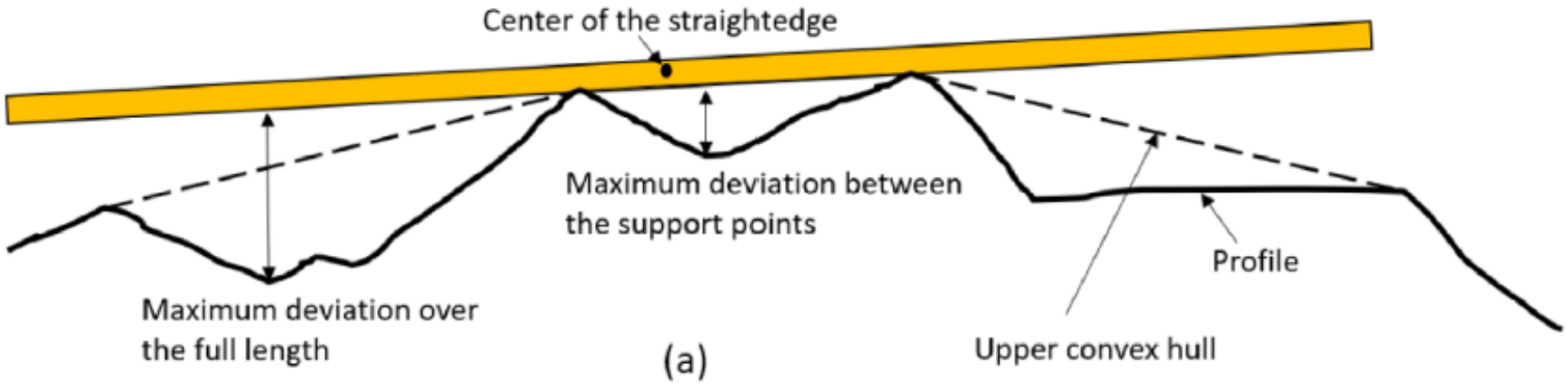
- The 15 feet long straight bar is supported by wheels on either end to move along the pavement.
- Test Method FM-509

Hettiarachchi, C., Yuan, J., Amirkhanian, S., & Xiao, F. (2023). Measurement of pavement unevenness and evaluation through the IRI parameter–An overview. Measurement, 206, 112284.

Rolling Straightedge (RSE)

How does RSE work?

- A particular vertical measurement can be set as a reference and any pavement **deviation** exceeding it will give an indication of a suspect area
- A **"bump" or "dip"** is recorded if it exceeds a certain threshold (3/16inch)



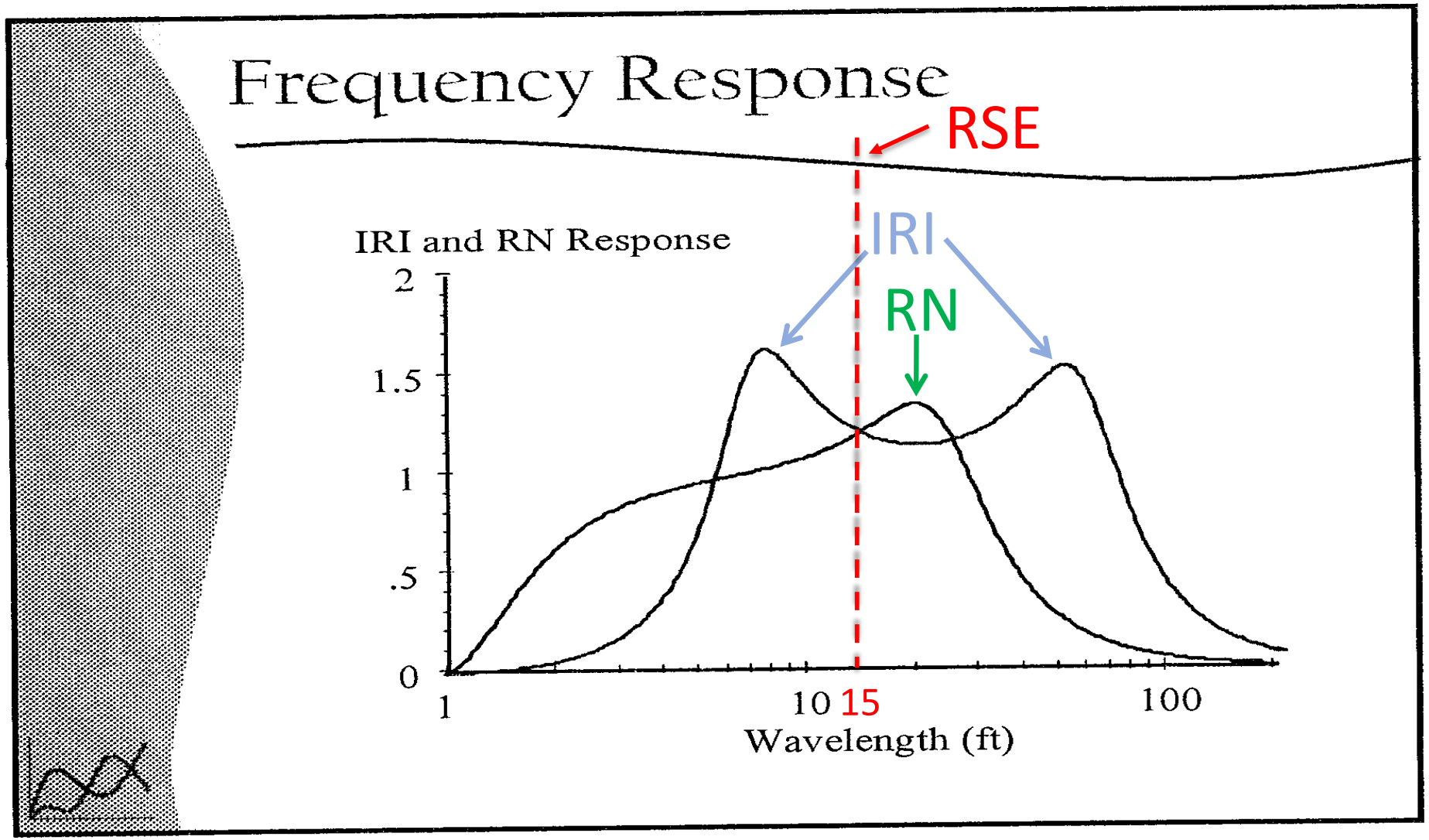
For acceptance, measure both wheel-path

Hettiarachchi, C., Yuan, J., Amirkhanian, S., & Xiao, F. (2023). Measurement of pavement unevenness and evaluation through the IRI parameter–An overview. Measurement, 206, 112284.

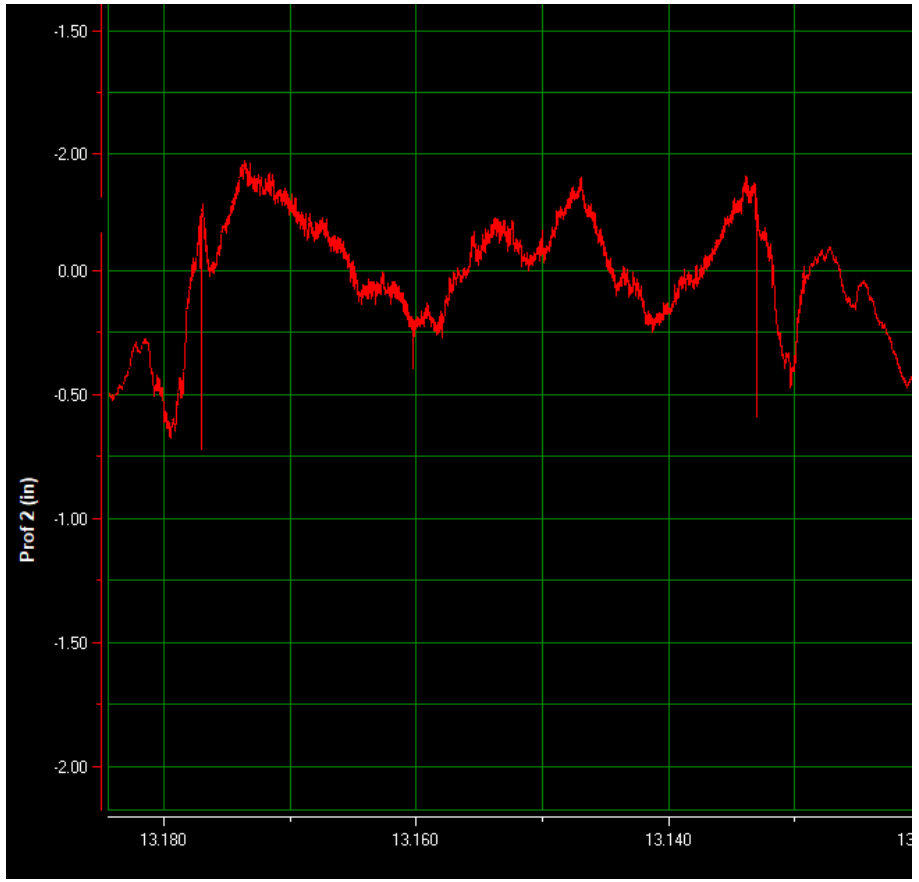
Laser Profiler vs. Rolling Straightedge – Key Differences

	Rolling Straightedge	Laser Profiler
Measurement Type	Manal, labor-intensive, low speed, require MOT	Automated, non-contact, traffic speed, high initial cost
Output	Localized surface deviation	IRI, RN smoothness index
Objective	Find bumps	Measure smoothness
Use cases	Localized areas, spot checks, quality control	Construction acceptance, network-level condition surveys
Environmental Limits	Affected by debris, gravel, and uneven joints manually	Affected by rain, debris

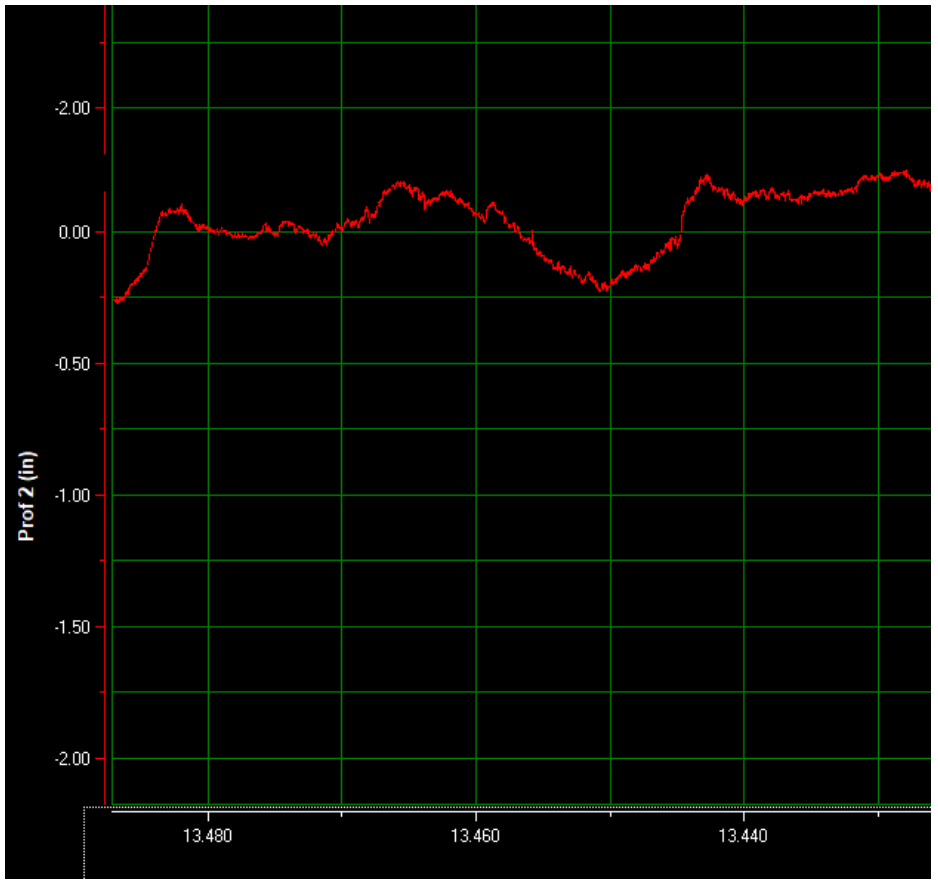
Critical Wavelengths – RN, IRI, and RSE



Pavement Smoothness: Laser Profiler Graphs



Rough pavement: larger, sharp, more frequent peaks and dips



Smooth pavement: smaller, flatter, low-amplitude waveforms

Field Case Study 1 – Pass RSE and Laser Profiler

When does this situation happen?

- No abrupt dips or bumps
- Consistent smoothness
- Uniform slope and elevation
- A well-constructed surface with both good local precision and good ride quality.

The pavement surface condition is uniform, smooth, and free from sharp localized defects or long-wave undulations.

Field Case Study 2 – Fail RSE and Laser Profiler

When does this situation happen?

- Sharp dips or bumps
- Longer-wave roughness
- Inconsistent paving surface
- A poor-constructed surface with both localized defects and overall poor ride quality,

The pavement has localized bumps or dips that exceed RSE tolerances, and it also has longer-wave roughness that degrade ride quality (low RN, high IRI)

Field Case Study 3 - Fail RSE and Pass Laser Profiler

How could this situation happen?

Laser profiler:

- Averages ride performance over segments (0.1 mile)
- Can “smooth over” very short dips if they don’t affect long area ride quality

Rolling Straightedge:

- Flags individual sharp bumps or dips, even though very short

The condition where the pavement has a localized bump or dip that’s too short to strongly affect overall ride quality, and the rest of the area is smooth and performs well.

Field Case Study 3 - Fail RSE and Pass Laser Profiler

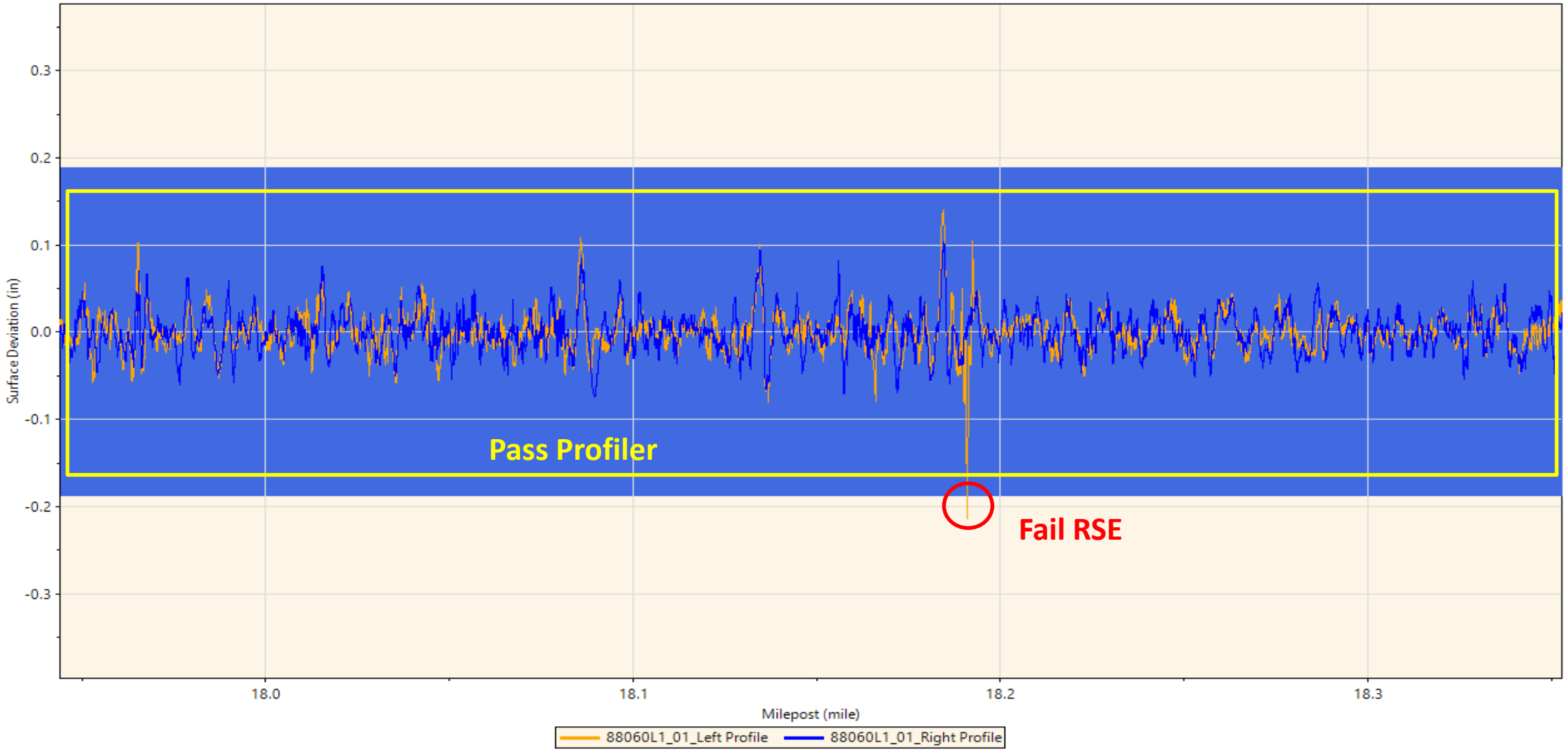
L1	RN result					RSE result (Simulated)		
	Milepost		0.1mile	0.01mile		Milepost		Dev. (inch)
	From	To	Avg. RN	RN left	RN Right	From	To	
Fail RSE and RN	21.776	21.766	3.9	4.0	2.7	21.7696	21.7691	0.246
						21.7685	21.7684	0.190
	17.236	17.136	3.9	2.3	4.0	17.1727	17.1724	-0.287
Fail RSE and Pass RN	18.196	18.186	4.1	3.2	4.2	18.1911	18.1909	-0.214

PASS

FAIL

- 3 Locations identified by RSE & Laser profiler. The 4th location was only **RSE failure**
- The same data analyzed under our IRI non-limited access class would qualify for incentive with no corrective actions.

Field Case Study 3 - Fail RSE and Pass Laser Profiler



Field Case Study 4 - Pass RSE and Fail Laser Profiler

How could this situation happen?

Laser profiler:

- Sensitive to longer wave irregularities, gentle but repeated undulations

Rolling Straightedge:

- Detects abrupt, short-distance deviations
- won't flag gradual changes that span over 15 feet, even if they cause discomfort

The condition where the pavement is gently but repeatedly uneven, has longer-wave, low-amplitude undulations/roughness, rather than having sharp localized defects.

Field Case Study 4 - Pass RSE and Fail Laser Profiler

	RN result					RSE result (Simulated)		
	Milepost		0.1mile	0.01mile		Milepost		Dev. (inch)
	From	To	Avg. RN	RN left	RN Right	From	To	
Fail RSE and RN	18.265	18.266	3.9	3.6	3.0	18.2604	18.2602	0.209
Fail RN and Pass RSE	18.325	18.315	3.9	3.4	3.6	18.325	18.2604	< 0.188
	18.215	18.205	3.9	4.0	3.4			
	18.195	18.185	3.9	4.2	3.2	18.2602	18.145	< 0.188
	18.155	18.145	3.9	4.1	3.4			

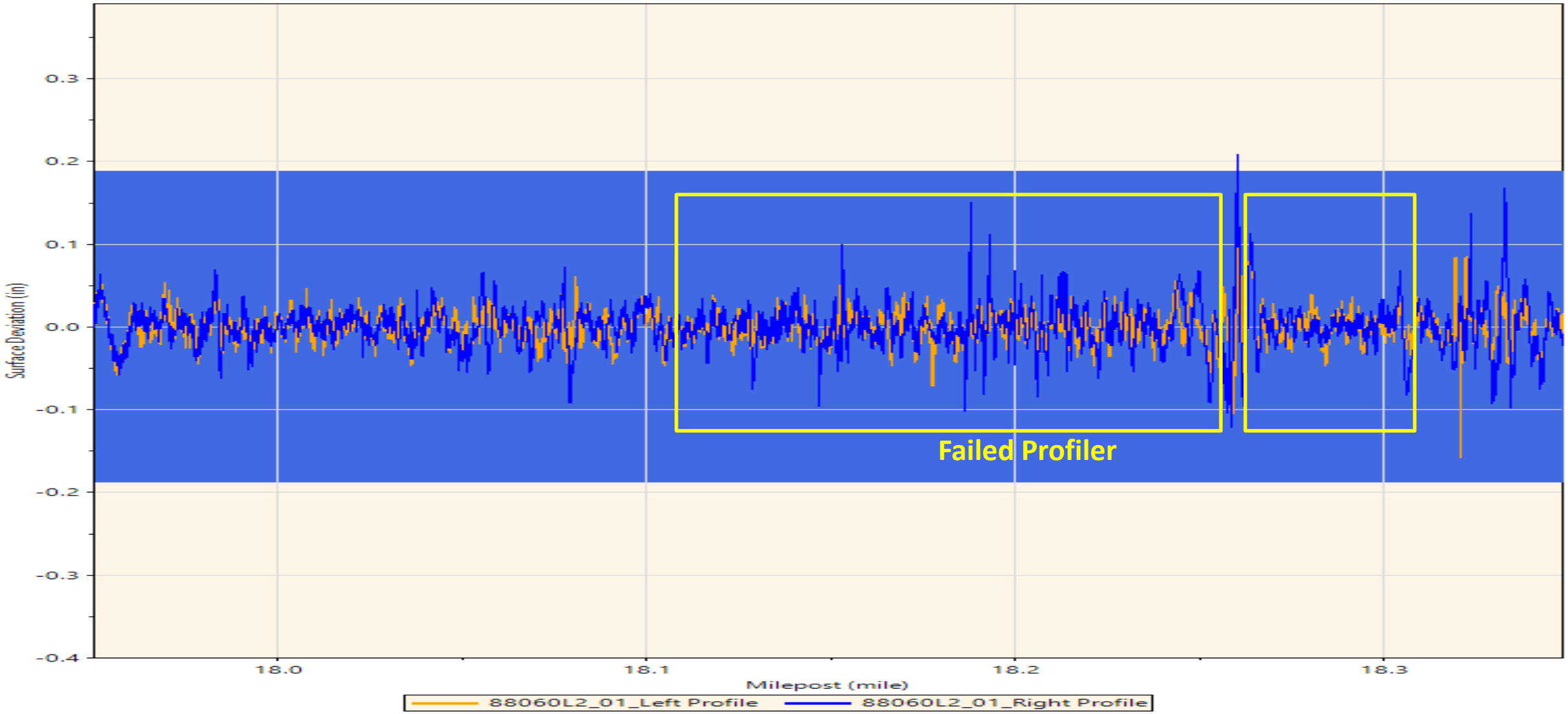
FAIL

PASS

The same data analyzed under our IRI non-limited access class would qualify for incentive with no corrective actions.

These areas would still pass for the overall 330 spec.

Field Case Study 4 - Pass RSE and Fail Laser Profiler



Key Takeaways

- Laser profiler (IRI & RN) provides a more comprehensive and overall ride-based continuous assessment of pavement smoothness.
- RSE is stricter for detecting sharp, localized defects. It’s a tool for spot-checking short-wave bumps or dips.
- RSE is still a valid method for contractor QC and leads to smooth roadways.

Questions

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