IRI – Great for Roads and Highways, But Not So Good on Runways

By Michael Gerardi

In the world of highway engineering, the International Roughness Index (IRI) is the go-to metric for evaluating pavement ride quality. It's standardized, widely understood, and backed by decades of use.

But on runways? IRI just doesn't measure up. In fact, using IRI to evaluate airfield pavement roughness may not only be misleading, but it could also mask real problems that impact aircraft safety, comfort, and structural fatigue.

A 2015 study by Emery, Hefer, and Horak makes that case convincingly. Their research lays out why IRI is fundamentally incompatible with aircraft dynamics, and what we should be using instead.

The Problem with IRI: It's Built for Roads, Not Runways

IRI was designed in the 1980s to model how a passenger car responds to pavement irregularities at a fixed speed of 50 MPH (80 km/h). It relies on a quarter-car model, which works well for sedans, SUVs, and trucks. But the ride dynamics of an aircraft are quite different.

- Aircraft gear is stiffer and less dampened.
- Aircraft operate at variable speeds, especially during takeoff and landing.
- Surface roughness creates dynamic loads and vertical acceleration that IRI completely misses.

As the study's authors state:

> *"IRI segment averages mask the impact of single or multiple roughness events… even when pilots are complaining about them." (Emery, Hefer, & Horak, 2015, p. 10)*

What About the Boeing Bump Index (BBI)?

The Boeing Bump Index was developed to quantify noticeable bumps on runways, specifically, those that trigger sudden vertical accelerations in aircraft. It identifies individual bumps in the pavement profile that may cause sudden vertical loads on the aircraft's main gear.

According to the research, BBI has proven useful for identifying single, high-impact events, and it's been successfully applied to several runway investigations where one distinct bump was clearly the source of pilot complaints.

However, as Emery and his co-authors point out, BBI is inherently limited:

- It does not account for aircraft speed, even though dynamic response varies significantly with velocity.
- It can only assess one bump at a time, making it ineffective when multiple roughness events occur in succession.

This last bullet is an important distinction, because most pilot and passenger complaints aren't produced by a *single bump or dip*. Most pilot and passenger complaints come from *multiple roughness events* in succession (multiple event roughness). In these cases, BBI underestimates the cumulative effect of runway roughness.

The researchers summarize this well:

> *"The Boeing Bump Index was not designed for multiple roughness events and should not be used where surface profiles show more than one deviation of interest." (Emery et al., 2015, p. 9)*

So, while BBI can be helpful in identifying a standout anomaly, it's not capable of evaluating the kind the most common type of runway roughness – multiple event roughness.

Why Roughness Evaluation Needs an Aircraft's Perspective

What truly matters for airfield roughness evaluation isn't just detecting a bump or dip, it's understanding how an aircraft responds to it. This is why simulation-based tools that model aircraft dynamics, gear geometry, and vertical acceleration have become more essential in recent years.

The Emery study confirms this:

> *"Aircraft responses are best evaluated using simulation tools that take into account aircraft speed, gear type, and cumulative roughness events." (Emery et al., 2015, p. 11)*

Why IRI Is Still Being Used (And Why It Shouldn't Be)

IRI remains popular with some regulatory agencies because the equipment is readily available, and the measurement process is familiar. But the study's authors are clear:

> *"IRI is not an appropriate index for evaluating airfield pavement roughness… and should not be used for runways." (Emery et al., 2015, p. 12)*

It's also not referenced in ICAO Annex 14 or FAA guidance for airfield smoothness. When used, IRI often underestimates the severity of the roughness or masks patterns of concern, especially long-wavelength roughness which can build a resonant condition for larger commercial aircraft.

What Should We Use Instead?

The paper recommends a layered approach:

- **Straight-edge compliance tests** 10 foot to 150-foot (3m and 45m). The smaller straightedge for smoothness and the larger, analytical straightedge for finding deviations that can produce poor aircraft responses.
- **Aircraft Simulation-based evaluations** to predict how an aircraft would respond to the profile.
- **Construction-phase tools** like the **Profile Index**, now computable via ASTM E950-compliant inertial profilers, for assessing smoothness prior to the pavement being placed into service.

Together, these methods paint a more accurate picture, one that reflects how an aircraft actually experiences the surface.

Final Thoughts

Smoothness matters, but the way we measure it matters even more. IRI may be a gold standard for roads and highways, but on the runway, it's measuring the wrong vehicle, at the wrong speed, using the wrong physics.

If your project involves airfield pavement and you're relying solely on IRI or BBI to assess surface roughness, it might be time for a deeper look. APR has your answers.

Citation:

Emery, S., Hefer, A. W., & Horak, E. (2015). *Roughness of Runways and Significance of Appropriate Specifications and Measurement*. 34th Annual Southern African Transport Conference. https://www.researchgate.net/publication/281632183