LOUISIANA TRANSPORTATION RESEARCH CENTER

Technical Summary

LTRC Report 713

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Performance Index Rating and Maintenance Cost Assignment for Ramps, Acceleration Lanes, and Deceleration Lanes in Louisiana

Introduction

Pavement smoothness, or roughness, is a key factor influencing ride comfort, safety, and pavement life. State agencies such as the Louisiana DOTD regularly measure roughness using the international roughness index (IRI) to support pavement management and federal reporting. Measurement methods on pavement smoothness have evolved from manual tools to high-speed inertial profilers, which use accelerometers, height sensors, and DMIs, with modern systems adding laser sensors for accuracy.

However, high-speed profilers struggle at low speeds, wherein speed changes cause measurement errors, especially on ramps, acceleration lanes, and deceleration lanes. Consequently, DOTD excludes these sections from performance index (PI) calculations, limiting effective pavement evaluation.

Research calls for solutions to low-speed profiling errors, including signal filtering and improved profilers with additional sensors. Several vendors now offer Stop-and-Go (SAG) inertial profilers designed for accurate data collection under varying speeds. This study evaluated SAG profilers for Louisiana roads, aiming to improve IRI and PI accuracy on ramps and low-speed segments, supporting better maintenance and asset management.

Objective

The objectives of the study were to:

- Evaluate the performance of a SAG inertial profiler under various driving conditions on Louisiana roads;
- Ascertain whether there are differences in IRI and PI values of Louisiana DOTD's analysis lanes compared to ramps, acceleration lanes, or deceleration lanes;
- Propose a method for measuring and characterizing IRI and PI values for ramps, acceleration lanes, and deceleration lanes to complement existing DOTD guidelines.

Scope

In this study, a SAG inertial profiler was loaned to the researchers for evaluation and initially compared to conventional high-speed profilers. It was then tested under various conditions at two DOTD certification sites to assess repeatability and accuracy. After demonstrating reliable performance, the profiler was used to collect IRI data on highway analysis lanes and adjacent ramps. The study analyzed differences in IRI and PI values between DOTD's analysis lanes and nearby sections such as ramps and acceleration and deceleration lanes, providing insights on their characterization and maintenance strategies.

Methodology

A SAG inertial profiler was rented from a manufacturer for two one-month periods in May 2022 and May 2024. The 2022 evaluation focused on comparing the SAG profiler with conventional systems, while the 2024 testing assessed SAG performance under specific conditions simulating real-world traffic scenarios.

2022 Evaluation: SAG vs. Conventional Profilers

Tests were conducted on asphalt and concrete sections in Louisiana using three profilers: SSI SAG profiler, Dynatest profiler (owned by LTRC, point laser), and Fugro profiler (line laser).

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Each profiler ran at two constant high speeds (30–55 mph). The SAG profiler also demonstrated stop-and-go capability with a single stop in selected sections. Each test was repeated three times, with IRI calculated over 528 ft. segments. ANOVA analysis was used to compare results at a 95% confidence level.

2024 Evaluation: SAG Under Varying Operating Conditions
Test Sites:
Site 1: LA 414 (dense-graded asphalt)
Site 2: LA 449 (stone mastic asphalt)

Each section was 1,128 ft. long with marked wheel paths and start and end cones for automated data collection. Cone markers guided operators.

Five operating conditions were evaluated; see Figure 1:

- Creep Speed (≤5 mph): Assesses numerical drift under low dynamic input.
- Deceleration-Acceleration (30 → 10 → 30 mph): Assesses pitch effects on accelerometer.
- Acceleration-Deceleration (15 → 30 → 15 mph): Same as above, reversed.
- Stop-and-Go: Full stop for 60 sec.: Assesses integration drift.
- Stop-and-Go + Creep: Stop, then creep at 4 mph before accelerating.

Two standards were used for evaluation:
DOTD TR 644

- Repeatability: Standard deviation of IRI ≤ 3 in./mi.
- Accuracy: Mean IRI within ±6 in./mi. of reference
- Includes DMI check, block check, and bounce test

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- Repeatability (IRI cross-correlation): ≥ 92
- Accuracy (IRI cross-correlation): ≥ 90
- Includes DMI check, software verification, block check, and bounce test

Following the certification trials, the SSI SAG inertial profiler was deployed to collect data for evaluating potential differences in IRI values between Louisiana DOTD's analysis lanes and adjacent features such as ramps, acceleration lanes, and deceleration lanes.

Conclusions

- The SAG inertial profiler can produce IRI values comparable to those measured by the conventional high speed inertial profilers at constant high operational speeds.
- Operational speed had no significant impact on the averaged IRI results obtained from the SAG inertial profiler when operating at a constant high speed.
- The single-stop operation of the SAG inertial profiler had no impact on its IRI measurements.
- The SAG inertial profiler can accurately and consistently measure profiles under special operational conditions, including acceleration and deceleration, low-speed operation, and stop-and-go scenarios on the LA 414 DOTD certification site.
- Pavement sections with extensive distresses, such as cracking and rutting, are not suitable for use as certification sites for inertial profilers.
- The ramps did not demonstrate the same or comparable IRI levels as the travel lanes.

Recommendations

- The SAG inertial profiler can be used to obtain accurate IRI measurements for ramps, deceleration lanes, and acceleration lanes.
- The performance index (PI) for special highway sections, including ramps, deceleration lanes, and acceleration lanes, can be reliably determined using valid IRI readings obtained from the SAG inertial profiler and calculated with existing DOTD equations.
- The actual treatment costs and maintenance needs should be assessed separately for ramps and adjacent travel/analysis lanes.
- DOTD may consider adopting SAG inertial profilers for network-level pavement smoothness evaluations to improve the accuracy of condition assessments, particularly for special highway sections such as ramps, deceleration lanes, and acceleration lanes.
- When utilizing SAG inertial profilers, DOTD should update certification procedures to ensure more effective evaluation of inertial profilers across various operational conditions.

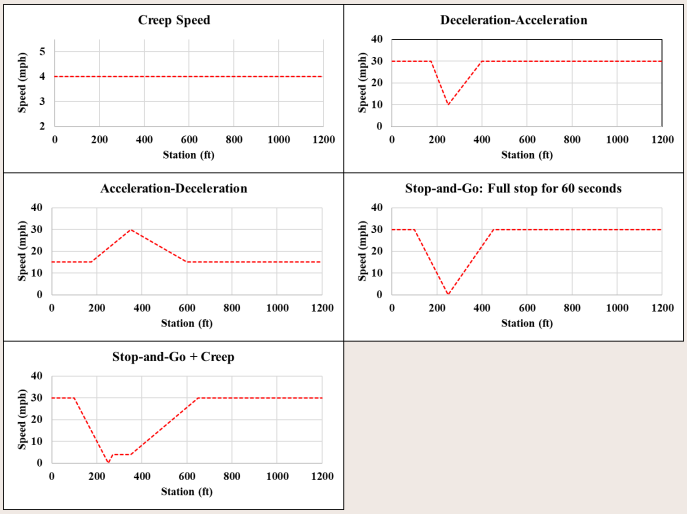

Figure 1. Five operating conditions