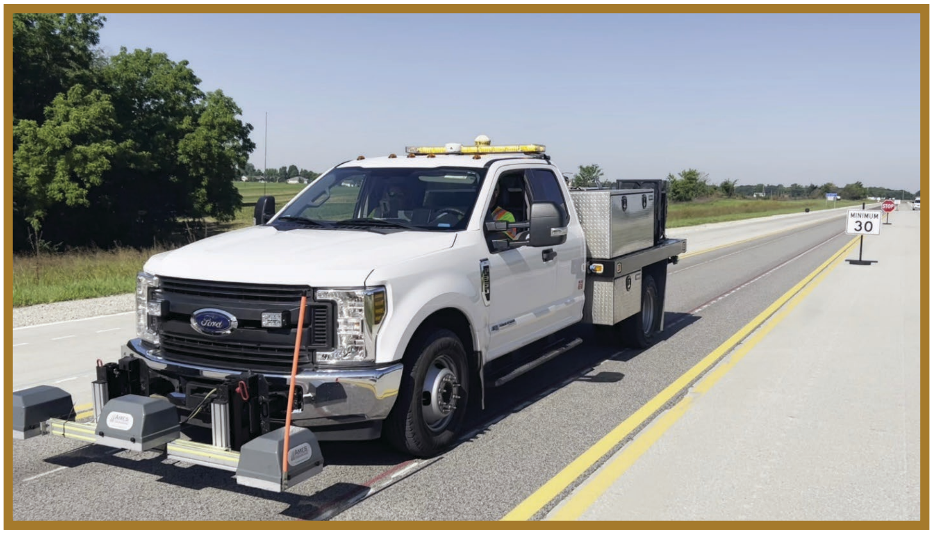
JOINT TRANSPORTATION
RESEARCH PROGRAM
INDIANA DEPARTMENT OF TRANSPORTATION
AND PURDUE UNIVERSITY

Demonstration of Zero Speed Inertial Profilers



Dwayne Harris and Steve Karamihas

SPR-4617 • Report Number: FHWA/IN/JTRP-2025/26 • DOI: 10.5703/1288284318560

RECOMMENDED CITATION

Harris, D., & Karamihas, S. (2025). *Demonstration of zero speed inertial profilers* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2025/26). West Lafayette, IN: Purdue University. https://doi.org/10.5703/1288284318560

AUTHORS

Dwayne Harris, PhD, PE, LPG
Research Engineer
Division of Research and Development
Indiana Department of Transportation
(765) 463-1521 ext. 246
dwharris@indot.in.gov
Corresponding Author

Steve Karamihas, PhD
Senior Engineer II
Applied Pavement Technology

ACKNOWLEDGMENTS

This research project was sponsored by the Indiana Department of Transportation (INDOT) in cooperation with the Federal Highway Administration through the Joint Transportation Research Program (JTRP). The authors would like to thank Joe Novak and Jacob Blanchard for helping develop the research idea for the project. Sincere thanks are extended to John Senger and the ICART personnel for assistance with the Zero Speed inertial profiler rodeo. The authors would like to acknowledge the input, comments, and help of study advisory committee (SAC) members: from INDOT; Greg Pankow, Joe Novak, Jacob Blanchard, and Tom Duncan (FHWA).

JOINT TRANSPORTATION RESEARCH PROGRAM

NOTICE

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA/IN/JTRP-2025/26	**2. Government Accession No.**	**3. Recipient's Catalog No.**

4. Title and Subtitle Demonstration of zero speed inertial profilers	**5. Report Date** September 10, 2025
	6. Performing Organization Code
7. Author(s) Dwayne Harris and Steve Karamihas	**8. Performing Organization Report No.** FHWA/IN/JTRP-2025/26
9. Performing Organization Name and Address Joint Transportation Research Program Hall for Discovery and Learning Research (DLR), Suite 204 207 S. Martin Jischke Drive West Lafayette, IN 47907	**10. Work Unit No.**
	11. Contract or Grant No. SPR-4617
12. Sponsoring Agency Name and Address Indiana Department of Transportation (SPR) State Office Building 100 North Senate Avenue Indianapolis, IN 46204	**13. Type of Report and Period Covered** Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. Abstract

The Indiana Department of Transportation (INDOT) currently uses inertial profilers for quality assurance and quality control (QA/QC) of newly constructed pavement. However, these profilers face limitations in urban environments characterized by low speeds and stop-and-go traffic. Specifically, their accelerometers struggle to accurately model vehicle movement under these conditions, leading to errors such as artificial localized roughness. Currently, equipment vendors are developing new profiler platforms that incorporate improved temporal and spatial filters, additional sensors, and novel computational methods to enhance performance in urban environments. The purpose of this research is to evaluate the performance of these updated systems in low-speed, stop-and-go urban environments.

17. Key Words stop-and-go inertial profiler, zero speed inertial profiler every speed inertial profiler, all speed inertial profiler, longitudinal profile	**18. Distribution Statement** No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages** 17, including appendices	**22. Price**

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

EXECUTIVE SUMMARY

The Indiana Department of Transportation (INDOT) currently uses inertial profilers for quality assurance and quality control (QA/QC) of newly constructed pavement. However, these profilers face limitations in urban environments characterized by low speeds and stop-and-go traffic. Specifically, their accelerometers struggle to accurately model vehicle movement under these conditions, leading to errors such as artificial localized roughness.

Currently, equipment vendors are developing new profiler platforms that incorporate improved temporal and spatial filters, additional sensors, and novel computational methods to enhance performance in urban environments.

The purpose of this research is to evaluate the performance of these updated systems in low-speed, stop-and-go urban environments. This was accomplished by following the certification procedures developed by the California Department of Transportation (Caltrans; Bhattacharya et al., 2024). This staged certification process includes profiles collected at multiple separate speed profiles.

The evaluation demonstrated significant progress in developing inertial profiler platforms suitable for urban, slow-speed conditions. However, challenges remain—particularly in capturing accurate profiles during braking. The need for skilled operators to achieve precise speed profiles was evident, especially for braking scenarios, where only 17% of attempts met the target criteria.

Nonetheless, all experimental platforms passed the repeatability requirements, and several approached or met accuracy benchmarks. Even where thresholds were not met, most scores exceeded 0.75, indicating substantial advancements in profiler technology for complex urban conditions.

One platform passed both the repeatability accuracy thresholds for all the speed profiles required for the Caltrans certification. The remaining platforms may pass certification with further development.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The Indiana Department of Transportation (INDOT) currently uses inertial profilers for quality assurance and quality control (QA/QC) of newly constructed pavement. However, these profilers face limitations in urban environments characterized by low speeds and stop-and-go traffic. Specifically, their accelerometers struggle to accurately model vehicle movement under these conditions, leading to errors such as artificial localized roughness.

To address these limitations, equipment vendors are developing new profiler platforms that integrate enhanced temporal and spatial filtering with additional sensor technologies. The purpose of this research is to evaluate the performance of these updated systems in low-speed, stop-and-go urban environments.

2. SCOPE

This report presents a background and findings from research on inertial profiler performance in urban environments. It evaluates emerging inertial profiler platform types that have been labeled as “Zero-Speed,” “Stop and Go,” “All Speed,” or “Every Speed.” The report also describes the experimental design of the equipment evaluation (“Rodeo”) held at the Illinois Certification and Research Track (ICART) test facility, outlines the test results, and concludes with recommendations.

3. BACKGROUND

A National Cooperative Highway Research Program (NCHRP) study evaluated the performance of inertial profilers on low-speed urban roads (Karamihas et al., 2019). The study found that areas of localized roughness were often introduced under two operational conditions during data collection. The first occurred when the brakes were released at the end of braking events, resulting in error throughout the event. The second condition involved collecting profile data while the vehicle was coming to a stop, which introduced an artificial change in elevation, leading to localized roughness.

The study also found that the speed of data collection affected the repeatability of the International Roughness Index (IRI) data. Data collected at higher speeds were more repeatable than data collected at speeds below 10–20 mph, depending on the equipment used. Karamihas et al. (2019) concluded, “Results from the experimental evaluation of production profilers justify the establishment of procedures for identifying conditions that cause invalid profile measurement, such as below a minimum speed or braking above a specific deceleration level” (p. 71). Inertial profilers, therefore, do not perform well in slow-speed, stop-and-go urban environments due to system limitations.

3.1 Inertial Profiler Overview

Huft (1984) described the basic components of an inertial profiler in a paper discussing the South Dakota Profilometer. An inertial profiler (Figure 3.1) includes:

- A height sensor to measure the distance between the sensor and the pavement surface;
- An accelerometer to model the motion of the vehicle; and
- A longitudinal Distance Measuring Instrument (DMI).

The equations used to calculate the road profile using temporal filtering are shown in Equation 3.1 through Equation 3.3. A basic temporal algorithm used in inertial profiling is illustrated in Figure 3.2 (Karamihas, 2021).

$$r_{zroad}(x) = r_{zref}(x) - \left(r_{zref}(x) - r_{zroad}(x)\right)$$

$$r_{zroad}(t) = \iint a_{zref}(t)\,dtdt - h(t), a_{zref} = vertical\,acceleration$$

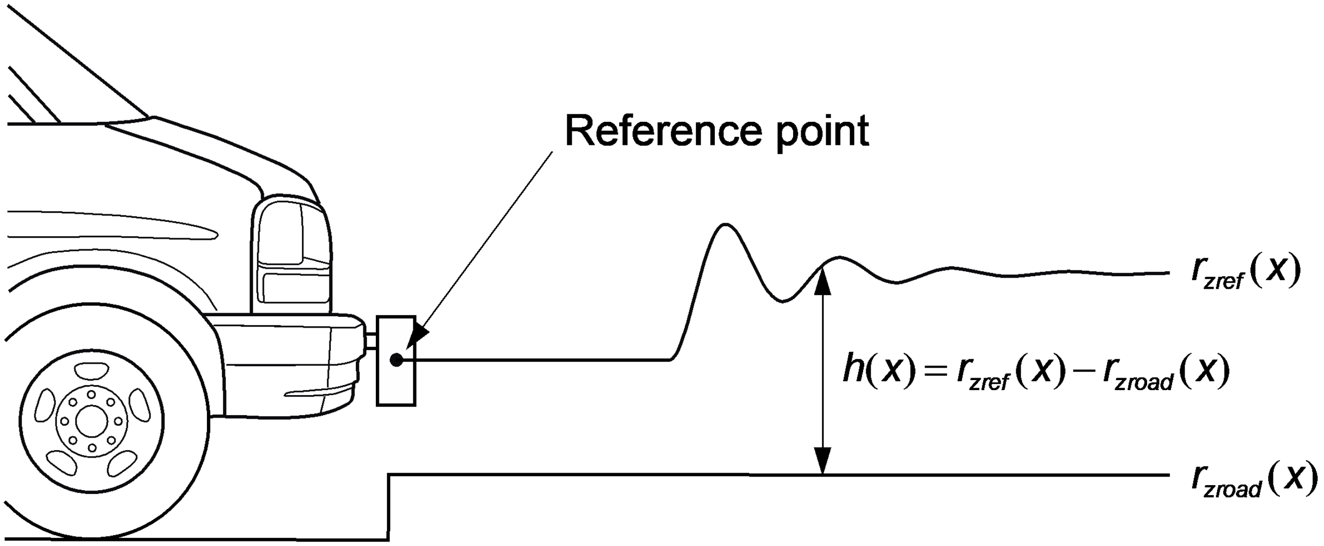
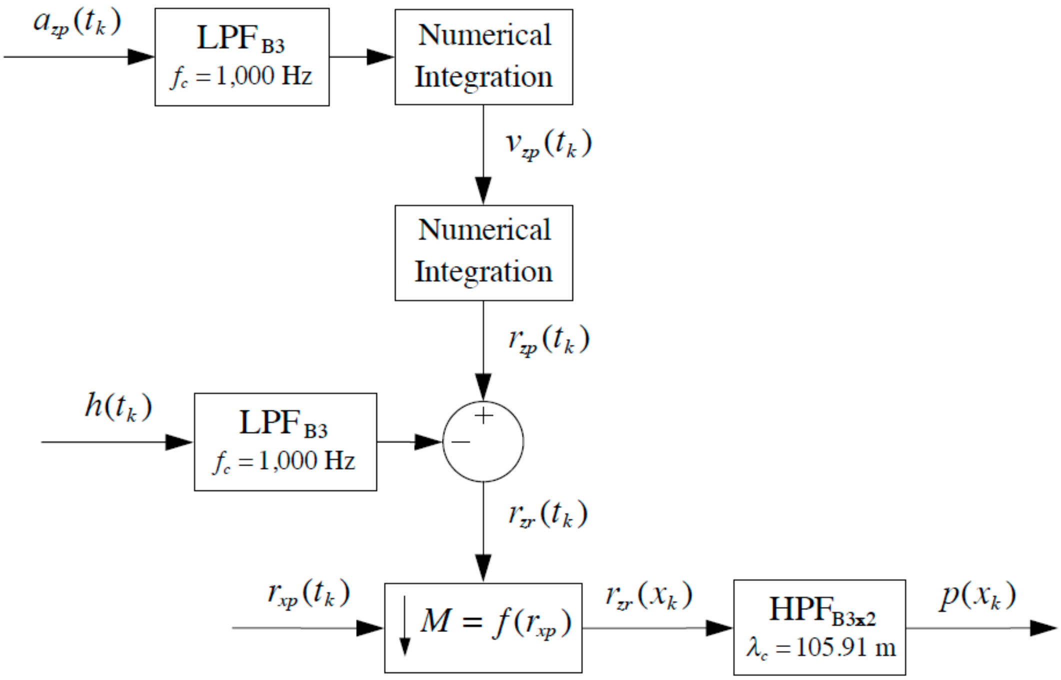


Figure 3.1 Inertial Profiler (Used with Permission: Karamihas, 2025).



$$a_{zp}(t_k) = a_{zref}(t),\ h(t_k) = height\ sensor\ signal,\ r_{xp}(t_k) = DMI\ Distance,\ r_{zr}(t_k)$$
$$= temporal\ profile,\ r_{zp}(t_k) = temporal\ reference,\ p(x_k)$$
$$= profile\ measurment\ spatial\ domain,\ M = decimation$$

$$HPF_{B3x2} = High\ Pass\ Butterworth\ filter,\ LPF_{B3} = Low\ pass\ Butterworth\ Filter$$

Figure 3.2 Basic Temporal Profile Calculations for Inertial Profiles (Karamihas, 2021).

$$r_{zroad}(x) = \iint \left(a_{zref}(x) \Big/ v_{xref}^{2}(x) \right) dxdx - h(x),$$

$$v_{xref} = vehicle\ forward\ speed\left(often\ assumed\ constant\right)$$

Inertial profilers are subject to speed restrictions largely due to accelerometer performance. While traveling at low speeds, during braking, or through stopping, accelerometer errors caused by drift and misalignment contaminate the data. These errors compromise profile accuracy and directly affect IRI calculations.

3.2 Sensor Augmentation for Improved Performance

A study from the University of Michigan Transportation Research Institute (UMTRI) showed that the performance of inertial profilers can be improved through filtering and sensor augmentation. Using only an accelerometer for motion compensation, inertial profilers could function adequately at slow speeds with the application of high-pass filters but not in stop-and-go situations (Karamihas, 2021).

To achieve adequate performance in both slow-speed and stop-and-go conditions, additional inertial sensors and filtering are required to accurately account for vehicle motion, including pitch and roll. UMTRI's enhanced platform incorporated multiple inputs from accelerometers, rate gyroscopes, and Global Positioning System (GPS) receivers. Kalman filtering was used for input processing and smoothing. With these enhancements, the profiler performed well under all operating conditions.

Currently, equipment vendors are offering new profiler platforms that incorporate improved temporal and spatial filters, additional sensors, and novel computational methods to enhance performance in urban environments.

3.3 Recommendations and Standards

The NCHRP study recommended updates to the American Association of State Highway and Transportation Officials's (AASHTO, 2025) Standard Practice for Certification of Inertial Profiling Systems (AASHTO R-56-14) to improve profiler performance in low-speed urban settings (Karamihas et al., 2019). These updates include specialized testing requirements for high-speed profilers used in urban environments and mandate data collection at multiple speed profiles, including low speeds and braking events.

Caltrans developed a Stop-and-Go inertial profiler certification procedure (Bhattacharya et al., 2024; Colbert et al., 2024). This procedure includes five speed profiles:

1. Constant speed (more than 45 mph)
2. Low speed (creep)

Figure 4.1 Left Wheel Track Marking.

3. Braking
4. Long stop
5. Stop with creep

This procedure served as the basis for the experimental evaluation of new inertial profiler platforms at the INDOT "Zero Speed Inertial Profiler Rodeo."

4. EVALUATION OF NEW INERTIAL PROFILER EQUIPMENT PLATFORMS: INDOT ZERO SPEED INERTIAL PROFILER RODEO

This experiment examined the repeatability and accuracy of road profile measurements collected at low speed, during braking, and through stops. The test program used methods proposed for revisions to AASHTO R 56-14 (AASHTO, 2025) and pilot tested during the development of California Test 387 (Colbert, et al., 2024) The tests were designed to: (1) determine the validity of profiles collected under speed conditions that typically cause errors in standard inertial profiler designs and (2) determine that range of profile that should be disregarded under various conditions if errors are found.

Background on the methodology appears in NCHRP Report 914. (Karamihas et al., 2019) The testing included profile measurement with five speed profiles that, collectively, posed a range of operational challenges that commonly occur during operation on urban and low-speed roadways in live traffic.

4.1 Test Section

Testing took place at the ICART facility in Clinton County, Illinois. All the tests were conducted on a 750-ft test section within the 9.5 mm dense graded hot mix asphalt (HMA) segment.

The location of the test section starting and ending points were clearly identified. Posts with reflective tape were provided at test section endpoints for automated triggering. The distance between markings of the starting and ending locations of an approximately 750-ft test segment was measured with a nylon-coated steel tape and temperature corrected.

The wheel track of interest was on the left side of the lane, 35 in. leftward of the lane center. Overpainting a rope with red marking chalk marked the center of the left wheel track. Figure 4.1 provides a close-up of the marking.

Some of the test runs described below required initiation of speed changes or stops at Landmarks. Figure 4.2 illustrates the layout of the Landmarks. A sign was placed along the left lane boundary at each Landmark.

4.1.1 Test Runs

Testing included three passes using each of five speed profiles:

4.1.1.1 Constant Speed. Pass over the test section at 45 mph, using cruise control, if possible.

4.1.1.2 Low Speed. Pass over the test section at very low speed. The desired speed is 3 mph. However, if the idle speed of the vehicle is greater than 3 mph, travel at the idle speed. The average speed for each run must be between 2–4 mph, and the speed must not exceed 5 mph at any location (see Figure 4.3, and Figure 4.4).

NOTE: Acceptance of the run depended on running at an average speed below 4 mph and registering no speed of 5 mph and above.

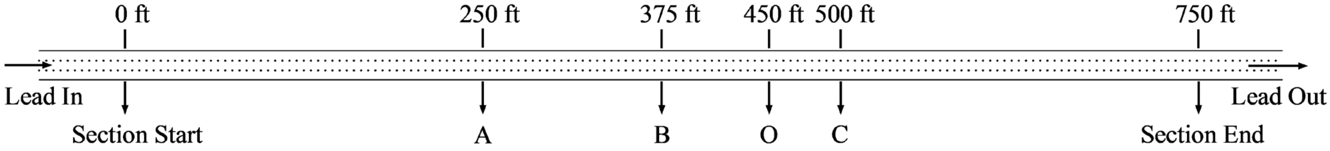


Figure 4.2 Test Section Layout.

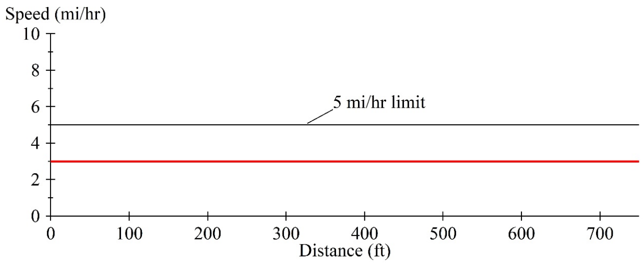


Figure 4.3 Low Speed Verses Distance.

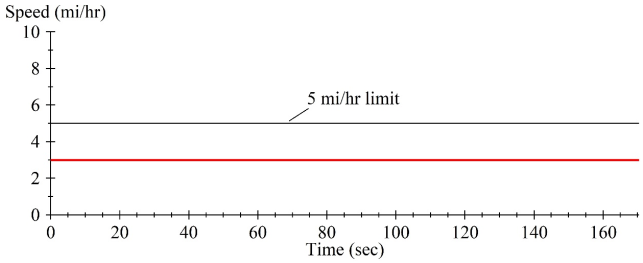


Figure 4.4 Low Speed Verses Time.

4.1.1.3 Braking. Enter the test section at a speed of at least 30 mph. Maintain a speed of at least 30 mph until Landmark B is reached. Once Landmark B is reached, decelerate smoothly to a speed of 15 mph or less at Landmark O. Traverse the rest of the test section at a speed of 15 mph or less (see Figure 4.2, Figure 4.5, and Figure 4.6).

NOTE: A change in speed from 30 mph to 15 mph over the distance from Landmark B to Landmark O corresponds to an average deceleration of 0.3 g (see Figure 4.2, Figure 4.5, and Figure 4.6).

NOTE: Acceptance of the run depended on maintaining speed above 30 mph from the start of the section up to Landmark B, and registering a speed below 15 mph at Landmark O (see Figure 4.2, Figure 4.5, and Figure 4.6).

4.1.1.4 Long Stop. Enter the test section at a speed of at least 30 mph. Maintain a speed of at least 30 mph until Landmark A is reached. After passing Landmark A, decelerate to a stop within 10 ft of Landmark O. Remain at the location of the stop for at least 60 seconds. After the 60-second wait, accelerate gently to 30 mph and continue to traverse the rest of the test section (see Figure 4.2, Figure 4.7, and Figure 4.8).

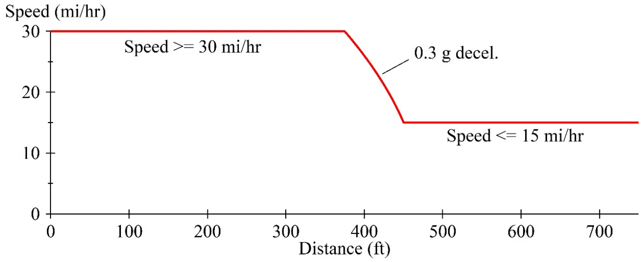


Figure 4.5 Braking Speed Verses Distance.

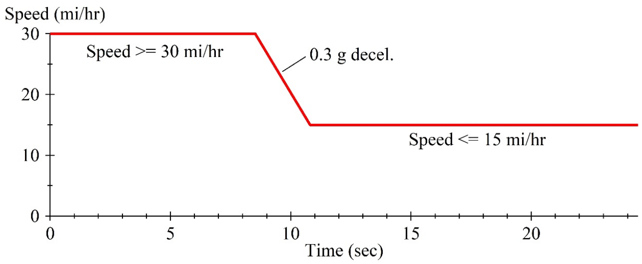


Figure 4.6 Braking Speed Verses Time.

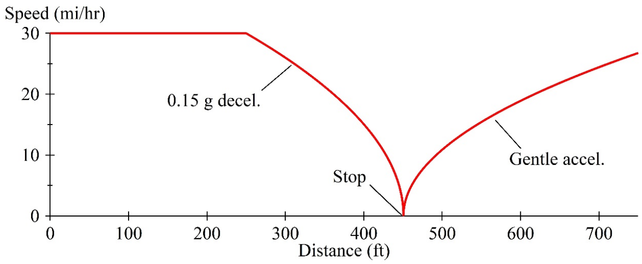


Figure 4.7 Long Stop Speed Verses Distance.

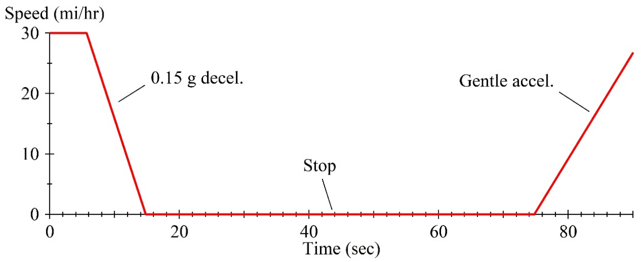


Figure 4.8 Long Stop Speed Verses Time.

NOTE: A change in speed from 30 mph to 0 mph over the distance from Landmark A to Landmark O corresponds to an average deceleration of 0.15 g (see Figure 4.2, Figure 4.7, and Figure 4.8).

NOTE: Acceptance of the run depended on maintaining speed above 30 mph from the start of the section up to Landmark A, stopping within 10 ft of Landmark O, and remaining still for 60 seconds or more (see Figure 4.2, Figure 4.7, and Figure 4.8).

4.1.1.5 Stop with Creep. Enter the test section at a speed of at least 30 mph. Maintain a speed of at least 30 mph until Landmark A is reached. After passing Landmark A, decelerate to a stop within 10 ft of Landmark O. Remain at the location of the stop for at least 5 s. After the 5-s wait, proceed to Landmark C at a speed of no greater than 5 mph. Once Landmark C is passed, accelerate gently to 30 mph and continue to traverse the rest of the test section (see Figure 4.2, Figure 4.9, and Figure 4.10).

NOTE: Acceptance of the run depended on maintaining speed above 30 mph from the start of the section up to Landmark A,

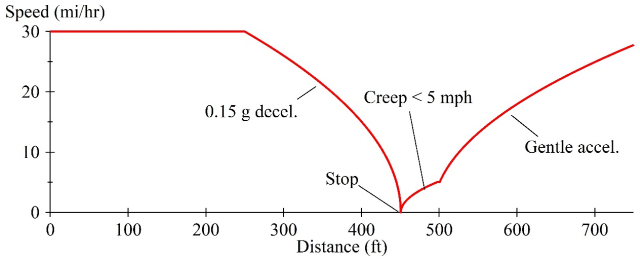


Figure 4.9 Stop With Creep Speed Verses Distance.

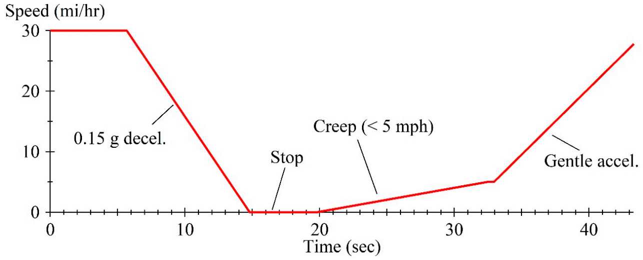


Figure 4.10 Stop With Creep Speed Verses Time.

stopping within 10 ft of Landmark O, remaining still for 5 seconds or more, and registering a speed of 5 mph or less between Landmark O and Landmark C (see Figure 4.2, Figure 4.9, and Figure 4.10).

4.1.2 Profiler Evaluation Process

Three passes conforming to the specification for each type of speed profile were required. Five attempts to achieve each speed profile were permitted. Acceptance of each run was determined by analyzing a speed profile provided with the data from each run, except stop durations. An observer timed the stop durations.

Provisions were made for access to a different test section with the same layout prior to collecting data on the HMA section so that drivers could practice achieving the required speed profiles.

4.2 Evaluation of Profilers

Six profilers participated in the experiment. Five of the profilers included systems for collecting valid profile at low speed, during braking, and through stops. The manufacturers operated those units. Those profilers are identified as units A–E. The other profiler (unit F) was a standard inertial profiler design. It participated to determine its sensitivity to adverse speed conditions, and to determine the range of profile around stops and heavy braking that should be excluded as invalid

All the profilers provided speed versus distance along with left elevation profiles. The five manufacturer-operated profilers also provided speed versus time. The time and distance resolution of the profilers are included in Table 4.1.

A SurPro 5000 collected reference profile measurements in the left wheel track. Four passes were collected with the SurPro.

TABLE 4.1
Distance and Time Resolutions for Each Participating Unit.

Profiler	Distanced Resolution (ft)	Time Resolution (s)
A	0.1	0.05
B	0.082	< 0.001
C	0.083	1
D	0.1256	0.12
E	0.1252	0.12
F	~ 1	—

TABLE 4.2
Number of Runs Meeting the Requirements for Each Speed Profile.

Profiler	A	B	C	D	E	F
Constant Speed	5	5	5	5	5	5
Low Speed	5	4	5	5	5	5
Braking	2	0	0	3	0	0
Long Stop	5	5	1	5	5	3
Stop with Creep	5	5	0	5	5	1

The average agreement score produced by cross-correlating the profile from each pass with the others was 0.977. The profile from the pass with the highest average agreement to the others was used as the reference profile.

4.2.1 Test Runs

Each profiler submitted data from five runs for each of the required speed profiles. Table 4.2 lists the number of runs collected by each profiler that adhered to the requirements for each speed condition.

For the low-speed runs, four of the profilers opted to maintain a speed near 3 mph. Two of the profilers opted to maintain a speed just below 4 mph. One of the runs with a target speed just under 4 mph failed to meet the requirements because the average speed was just above 4 mph.

For the runs with a long stop, an observer ensured that the duration of the stop was 60 s or more during all runs. Speed versus time data verifying the 60-s-long stop for the manufacturer-operated profilers. Figure 4.11 shows speed versus distance for five runs that passed the speed criteria for the runs with a long stop. The plot verifies that braking from a speed above 30 mph did not begin until the proper location and that the stop occurred at the correct location.

Figure 4.12 shows speed versus distance for a set of runs that did not satisfy the speed criteria for the runs with a long stop. In four of the runs, braking to a speed below 30 mph began before the designated location. All the runs that failed to meet the criteria failed because of premature braking. Note the critical challenge posed by this speed profile was the 60-s-long stop, so all of the runs provide useful information regardless of the premature start of braking. As such, they were included in the analysis.

For the runs with a stop with creep, an observer ensured that the duration of the stop was 5 s or more during all the runs. Speed versus time data verifies the 5-s-long stop for the

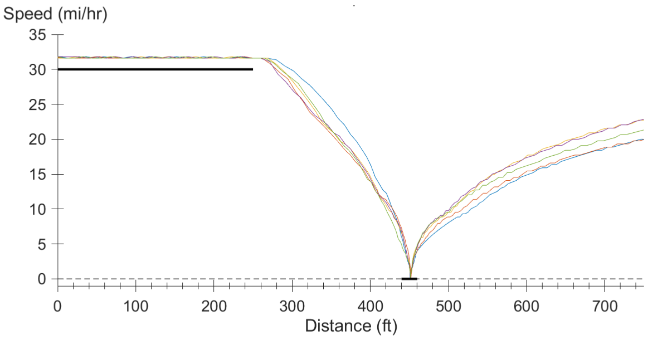


Figure 4.11 Five Passing Speed Profiles for Runs With Long Stop.

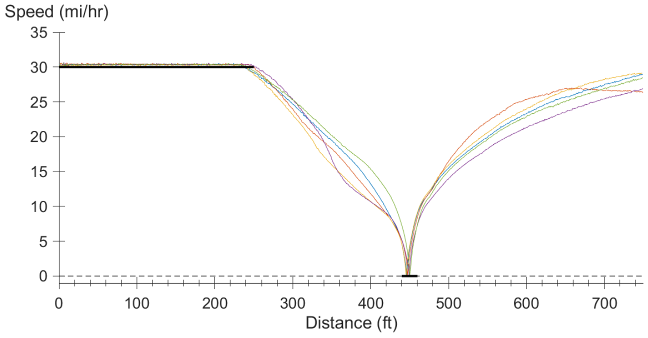


Figure 4.12 Five Failing Speed Profiles for Runs With Long Stop.

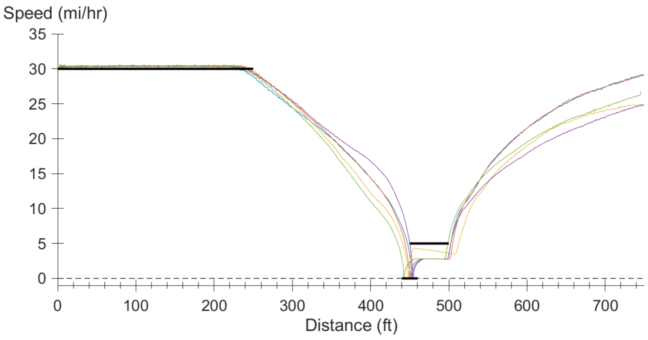


Figure 4.14 Five Failing Profiles for the Runs With Stop and Creep.

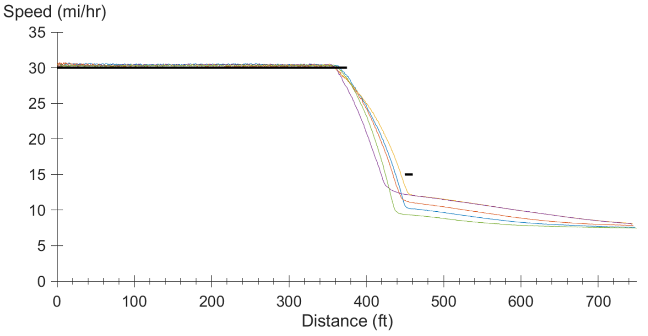


Figure 4.15 Five Speed Profiles for the Breaking Runs.

manufacturer-operated profilers. Figure 4.13 shows speed versus distance for five runs that pass the speed criteria for the runs with a stop with creep. The plot verifies that braking from a speed above 30 mph did not begin until the proper location, that the stop occurred at the correct location, and that the speed was held below 5 mph for 50 ft of travel after the stop.

Figure 4.14 shows speed versus distance for a set of runs that did not satisfy the speed criteria for the runs with a stop. In all five of the runs, braking to a speed below 30 mph began before the designated location. All the runs that failed to meet the criteria failed premature braking. Note that the critical challenge posed by this speed profile was the 5-s-long stop followed by travel at low speed, so all of the runs provide useful information regardless of the premature start of braking. As such, they were included in the analysis.

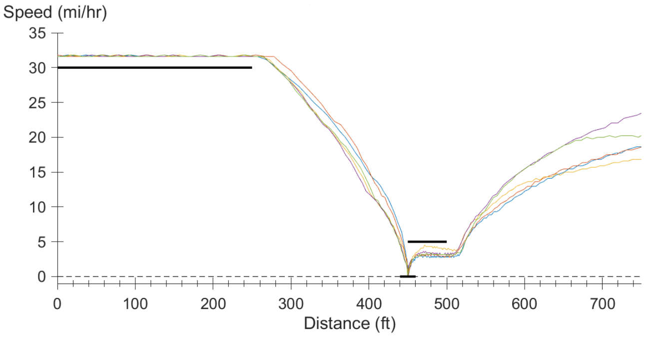


Figure 4.13 Five Passing Profiles for the Run With Stop and Creep.

TABLE 4.3
Number of Runs Included in the Data Analysis.

Profiler	A	B	C	D	E	F
Constant Speed	5	5	5	5	5	5
Low Speed	5	4	5	5	5	5
Braking	4	5	3	5	5	1
Long Stop	5	5	5	5	5	5
Stop with Creep	5	5	5	5	5	5

The braking runs posed a challenge to the operators of all six profilers. Figure 4.15 shows speed versus distance for five braking runs by one of the profilers. In all five runs, the braking started before the designated location. Starting the braking early was a common source of difficulty, and only 5 of the 30 attempts at the braking run would have passed if the rules were applied strictly. Instead, a braking run was accepted for analysis if the speed change from above 30 mph to below 15 mph was achieved over a distance of 75 ft or less, regardless of the location where braking began. For the five runs in Figure 4.15, three were included in the analysis.

Table 4.3 lists the number or runs included in the analysis for each profiler and speed condition.

TABLE 4.4
Accuracy Scores.

Profiler	A	B	C	D	E	F
Constant Speed	0.948	0.849	0.898	0.908	0.906	0.930
Low Speed	0.936	0.913	0.854	0.896	0.921	0.755
Braking	0.937	0.838	0.905	0.845	0.751	0.432
Long Stop	0.944	0.817	0.910	0.813	0.812	0.003
Stop with Creep	0.946	0.777	0.910	0.760	0.762	0.010

TABLE 4.5
Repeatability Scores.

Profiler	A	B	C	D	E	F
Constant Speed	0.984	0.927	0.939	0.961	0.944	0.948
Low Speed	0.991	0.976	0.987	0.973	0.946	0.745
Braking	0.978	0.956	0.953	0.959	0.912	—
Long Stop	0.974	0.948	0.964	0.960	0.910	0.861
Stop with Creep	0.986	0.961	0.966	0.967	0.913	0.685

TABLE 4.6
Reproducibility Scores.

Profiler	A	B	C	D	E	F
Low Speed	0.979	0.810	0.839	0.949	0.923	0.786
Braking	0.975	0.762	0.903	0.882	0.718	0.475
Long Stop	0.975	0.767	0.909	0.871	0.782	0.003
Stop with Creep	0.974	0.743	0.917	0.816	0.720	0.010

4.2.2 Cross Correlation Results

Table 4.4 and Table 4.5 provide cross-correlation accuracy and repeatability scores, respectively. The cross-correlation was performed using the raw output of the IRI algorithm, as required by AASHTO R56-14 (AASHTO, 2025). Each comparison used an adjustment to the starting point of the profiles of up to 5 ft in either direction to seek the best agreement score, which accounts for small inconsistencies in triggering at the test section boundaries. However, no adjustment was made to the longitudinal DMI calibration.

Some of the accuracy scores at constant speed were lower than the AASHTO R56-14 requirement of 0.90 (AASHTO, 2025). The modest accuracy scores suggested that the specialized systems for operating at low speed, during braking, and through stops were functioning as intended, but that the nominal level of accuracy of the profiler was insufficient. Table 4.6 examines the comparison between runs with the low speed, braking, stop, and stop with creep speed profiles to the runs at a constant speed near 45 mph. Typically, the scores represent the average of 25 comparisons: each of five runs with a given speed profile to each of five runs at constant speed (see Table 4.6). The scores represent the ability of each profiler to reproduce its profile measurements collected under favorable conditions when operating under less favorable conditions.

5. CONCLUSIONS

The purpose of this research was to gauge the performance of these new equipment platforms in urban low-speed, stop-and-go environments. The evaluation demonstrated significant progress in developing inertial profiler platforms suitable for urban, slow-speed conditions. However, challenges remain—particularly in capturing accurate profiles during braking. The need for skilled operators to achieve precise speed profiles was evident, especially for braking scenarios, where only 17% of attempts met the target criteria.

Nonetheless, all experimental platforms passed the repeatability requirements, and several approached or met accuracy benchmarks. Even where thresholds were not met, most scores exceeded 0.75, indicating substantial advancements in profiler technology for complex urban conditions.

One platform passed both the repeatability accuracy thresholds for all the speed profiles required for the Caltrans certification. The remaining platforms may pass certification with further development.

REFERENCES

American Association of State Highway and Transportation Officials. (2025). *Standard Practice for Certification of Inertial Profiling Systems* (R 56). American Association of State Highway and Transportation Officials.

Bhattacharya, B. B., Schaefer, N., Spears, R., & Colbert, B. (2024). Development and implementation of stop-and-go inertial profiler certification procedure in California. *Transportation Research Record*, *2679*(3), 312–329. https://doi.org/10.1177/03611981241277823

California Department of Transportation (2023, September). *Method of test for operation, calibration and operator certification of inertial profilers* (California test 387). https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/californiatestmethods-ctm/ct-387-sep2023-a11y.pdf

Colbert, B., Spears, R., Karamihas, S., Schaefer, N., & Bhattacharya, B. (2024). *Evaluation of the stop-and-go inertial profiler* (California Department of Transportation Report No. Caltrans-METS-IPCP-24-01). California Department of Transportation, Materials Testing and Engineering Services.

Huft, D. L. (1984). South Dakota profilometer. *Transportation Research Record*, (1000), 1–8. http://onlinepubs.trb.org/Onlinepubs/trr/1984/1000/1000-001.pdf

Karamihas, S. M., Gilbert, M. E., Barnes, M. A., & Perera, R. W. (2019). *Measuring, characterizing, and reporting pavement roughness of low-speed and urban roads* (National Cooperative Highway Research Program Report 914). https://doi.org/10.17226/25563

Karamihas, S. M. (2021). *Improvement of inertial profiler measurements of urban low-speed roadways* [Unpublished doctoral dissertation]. University of Michigan.

Karamihas, S. M. (2025, April 29). *Pilot certification of profilers for use at low speed, during braking, and through stops* [Conference session]. Road Profile Users' Group Annual Conference, Dallas, TX, United States.

APPENDICES

Appendix A. Cross Correlation Results With DMI Adjustment

Appendix A: Cross Correlation Results With DMI Adjustment

Table A.1 through Table A.3 provide cross correlation results for IRI algorithm output using optimal DMI adjustment. These agreement scores are counterparts to the results in Table 4.4 through Table 4.6, with the exception that adjustments to the DMI calibration of up to 1% were used to seek the highest level of agreement.

Table A.1 *Accuracy Scores With DMI Adjustment.*

Profiler	**A**	**B**	**C**	**D**	**E**	**F**
Constant Speed	0.949	0.860	0.901	0.909	0.910	0.933
Low Speed	0.936	0.913	0.924	0.898	0.921	0.760
Braking	0.937	0.858	0.913	0.892	0.872	0.735
Long Stop	0.944	0.827	0.931	0.846	0.865	0.003
Stop with Creep	0.946	0.799	0.919	0.844	0.858	0.010

Table A.2 *Repeatability Scores With DMI Adjustment.*

Profiler	**A**	**B**	**C**	**D**	**E**	**F**
Constant Speed	0.984	0.928	0.940	0.962	0.947	0.948
Low Speed	0.991	0.976	0.987	0.974	0.947	0.748
Braking	0.978	0.957	0.969	0.959	0.913	—
Long Stop	0.974	0.950	0.966	0.962	0.917	0.862
Stop with Creep	0.987	0.962	0.967	0.967	0.917	0.689

Table A.3 *Reproducibility Scores With DMI Adjustment.*

Profiler	**A**	**B**	**C**	**D**	**E**	**F**
Low Speed	0.980	0.817	0.930	0.952	0.927	0.788
Braking	0.976	0.765	0.917	0.937	0.866	0.814
Long Stop	0.975	0.768	0.918	0.905	0.848	0.003
Stop with Creep	0.975	0.746	0.919	0.901	0.833	0.011

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at docs.lib.purdue.edu/jtrp/.

Further information about JTRP and its current research program is available at engineering.purdue.edu/JTRP.

About This Report

An open access version of this publication is available online. See the URL in the citation below.

Harris, D., & Karamihas, S. (2025). *Demonstration of zero speed inertial profilers* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2025/26). West Lafayette, IN: Purdue University. https://doi.org/10.5703/1288284318560