



TRC0308

**Development of Smoothness  
Specification for ACHM Pavements**

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Final Report

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Arkansas State Highway & Transportation Department  
Transportation Research Committee

# Final Report

## TRC 0308

DEVELOPMENT OF SMOOTHNESS  
SPECIFICATIONS FOR ACHM PAVEMENTS



Final Report

**TRC 0308**  
**DEVELOPMENT OF SMOOTHNESS SPECIFICATIONS FOR ACHM PAVEMENTS**

Research Section  
System Information and Research Division  
Arkansas State Highway and Transportation Department

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## OVERVIEW

The goal of this project initially was to develop a smoothness specification for Asphalt Concrete Hot Mix (ACHM) pavement overlays primarily for incentives that would be based on the Profile Index (PI) and the International Roughness Index (IRI). This project later led to writing a Special Provision (SP) for ACHM and Portland Cement Concrete (PCC) pavements based on the IRI data collected.

Throughout the duration of this project, the goal changed based on the needs of the Department. Longitudinal profile data of both before and after data for new construction and overlay jobs were collected throughout the state of Arkansas. The basis of collecting this data was to determine an adequate percent reduction or improvement after the overlay had been completed. Additional data was collected to determine a specific range of PI and IRI that could be attained before writing the specification. Data were collected on both ACHM and PCC pavements.

For the TRC 0308 final report, SP for ACHM and PCC will suffice. The PCC SP will be used for an upcoming job, but ACHM SP is under review. Values in the SPs were concluded based on data collected in Arkansas and literature collected from surrounding states. For additional information on equipment used to collect data, please refer to TRC 0208. For additional information on approved specifications, please contact the Construction Division. Please note that the attached SPs are subject to change.

**ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT**

**SPECIAL PROVISION**

**PCC Pavement Surface Smoothness**

This Special Provision supersedes Subsection 501.05(m) and 501.12 of the Standard Specifications.

**Description.** It is the intent of this specification to produce a pavement that is durable and consistently exceeds the minimum test values in these specifications. The pavement surface smoothness and associated payment adjustments will be determined by the use of the Inertial Profiler (IP) and the International Roughness Index (IRI). Pavement smoothness will be determined for each lane by obtaining the IRI for the left and right wheel paths in an individual lane. The difference in the left and right wheel path shall not exceed 5%. The averaged IRI values will be used to determine payment adjustments for each 0.1 mile section.

**Equipment and Operator.** The Contractor shall furnish a properly calibrated, documented. The IP shall export raw profile data in an unfiltered ERD file format and an approved ADF file format. The IP shall also produce a profilogram (profile trace of the surface tested). The IP shall conform to the Class I requirements of the most recent revision of ASTM E950.

Profile analysis for determination of IRI and areas of localized roughness will be conducted using ProVAL version 3.6 or the most recent version of ProVAL Software. IRI values shall be reported in inches/mile (in/mi).

The Contractor shall furnish an operator, trained in the operation of the particular IP.

**Pavement Surface Testing.** In the presence of the Engineer, the Contractor shall setup a test section to calibrate the distance sensor and check the profile system calibration before each day's testing. Unless otherwise authorized by the Engineer, all smoothness testing shall be performed in the presence of the Engineer. For the duration of the work, every reasonable effort shall be made to test smoothness within 5 working days after each day's paving operation. Scheduling and testing shall be coordinated with the Engineer. The Engineer and the Contractor shall mutually agree upon scheduling of smoothness testing.

The Contractor shall remove all objects and foreign material on the pavement surface prior to surface evaluation. The Contractor will be responsible for all traffic control associated with testing and any corrective work (when applicable) that is required of the final pavement surface.

The IP shall be run in the final design direction of traffic. Profiles shall be measured in the left and right wheel paths of each lane. Each lane's wheel path shall be tested and evaluated separately. The Engineer shall determine the length in miles for each mainlane of traffic. The IP shall be operated at the optimum speed as defined by the manufacturer.

The Contractor shall profile the final surface of the entire job length to determine if the pavement meets the smoothness values specified below and to determine the total incentive/disincentive,

The Engineer will verify the profiles by testing approximately 10% of the pavement. This testing will be performed by the Engineer, using either the IP furnished by the Contractor or one provided by the Department, at the option of the Engineer.

For the first day's run, profiles will be taken utilizing the IP as soon as the hardness of the concrete is sufficient for proper testing. Smoothness profiles of the first day's run will be analyzed before the second day's run commences. Should the day's run exceed an IRI of 75 inch/mile the paving operations shall be discontinued until better methods and equipment are obtained or until the present equipment is properly adjusted. If adjustments are necessary from the first day's run, the second day's run will be profiled to determine the ability of the equipment to finish the pavement within specified tolerance. If the second day's operation fails to produce a finished surface IRI of 75 inch/mile or less, the contractor shall produce new methods and/or equipment that will obtain the specified results. The new methods and/or equipment will be given trial runs as indicated previously for original equipment. The finished pavement surface will be measured for roughness by the Contractor. Roughness will be measured using an IP. The IRI shall not exceed 75 inches per mile 0.1 mile section (1.60m per km per 0.8 km section). Bridges or any other non-ground sections will not be included in the calculation of the IRI.

Areas of localized roughness will be identified using the ProVAL "Smoothness Assurance" analysis, calculating IRI with a continuous short interval of 25 ft. (7.62 m) and the 250-mm filter applied. The longitudinal limits of corrective work shall be taken from the ProVAL "Grinding" section within the "Smoothness Assurance" analysis, using the "Default Grinding Strategy" option. The finished surface of 25' (7.5 m) sections adjacent to an existing structure or the end of pavement shall not show surface deviations in excess of 1/8" (3 mm) in 10' (3 m) with the approved inertial profiler.

Areas showing low spots of more than 1/4" (6 mm) in 10' (3 m) in the longitudinal direction shall be corrected by grinding or shall be removed and replaced according to Section 507 to an elevation that will not show surface deviations in excess of 1/8" (3 mm) in 10' (3 m).

Grinding shall be performed, if necessary, to reduce the IRI as determined by the Smoothness Assurance analysis in ProVAL. The grinding equipment shall be power driven and specifically designed to smooth and texture PCC by means of diamond blades. Areas that have been ground shall be re-grooved by grooving according to Subsection 510.04, to provide a uniform texture equal in roughness to the surrounding unground pavement. The grinding process shall produce pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type of appearance. The peaks of the ridges shall be approximately 1/32" (0.8 mm) higher than the bottoms of the grooves with approximately 53 to 57 evenly spaced grooves per foot (170 to 190 evenly spaced grooves per meter).

Vertical misalignment of the surfaces on adjacent sides of the joints that is in excess of 1/16" (2 mm) shall be ground until the surfaces are flush.

The transverse slope of the pavement shall be uniform to a degree that no depressions or misalignment of slope greater than 1/4" (6 mm) in 10' (3 m) are present when tested with a straightedge placed perpendicular to the centerline.

However, if the ground area is less than 50' (15 m) in length and full width of pavement lane, re-grooving will not be required.

After the areas of localized roughness have been identified and grinding has taken place, the smoothness of the pavement shall be measured again to determine if the pavement has met the smoothness requirements for 100% pay. If grinding of localized roughness is required as described previously, incentives will not be allowed on that section, but the Contractor can receive a maximum of 100% pay. However, continual production of a final surface not qualifying for full payment will not be allowed.



The difference in the left and right wheel path shall measure no more than 5.0% of the averaged left and right wheel path. When any of the points on the left or right wheel path differs by more than 5.0% of the corresponding averaged wheel path reading, the segment shall be ground to a differential of 5.0% or less. If any differential needs to be corrected by grinding the lane segment will not qualify for incentive, even if IRI requirements have been achieved.

The averaged IRI values will be used to determine payment adjustments. The right and left wheel path readings will be averaged for every point read during the 528' lane segment. Areas less than 0.1 mile (200 m) shall be combined with a full 0.1 mile segment before profiling. Then the left and right averaged wheel path points will be averaged to obtain an IRI value for the lane segment.

For isolated areas that are not connected to adjacent paved areas, a 10' rolling straightedge will be used to determine areas of localized roughness, following the method specified in Subsection 410.09(b)(2) of the Standard Specifications for Highway Construction, 2014 Edition. The 10' rolling straightedge will also be used to determine areas of localized roughness on transverse joints, construction joints, bridge ends, and any other area designated by the Engineer.

**Submittals.** The Contractor shall submit the printed profile trace (graphical trace) signed by the operator, indicating each segment's averaged IRI value, to the Engineer no later than the close of the business on the following day that the profiling is conducted.

The Contractor shall also submit electronic files, with the printed profile trace, in ERD and ADF format that represent the raw data from each pass. The electronic file names shall follow the standardized format shown in the following.

YYMMDD-J-T-N-D-L-W-S

Where:

YY=Two-digit year

MM=Month (including leading zeros)

DD=Day of Month (including leading zeros)

J=the Department Job Number

T=Route Type (I, AR, US, etc.)

N=Route Number (no leading zeros) and auxiliary ID (if applicable, i.e. E, W)

D=Primary route direction (I or D, indicating Increasing or Decreasing; Increasing = North or East, Decreasing = South or West)

L=Lane number (1 for driving lane, increasing by one for each lane to the left)

W=Wheel path (L (left), R (right), or B (both))

S=Beginning Station

Pavement smoothness within each wheel path will be measured in terms of IRI (in/mi) according to the Pavement Surface Testing section above. Price adjustments apply to the total area for the lane width represented by the profile index for a continuous mainlane section at least 0.1 mile (200 m) long. Price adjustments for incentives are only based on the initial measured profile index of continuous sections of at least 0.1 mile (200 m) in length, excluding approach slabs and bridges, and before any corrective work; however, grinding will be allowed to achieve 100% full payment in lieu of accepting a disincentive for that section. Ramps, acceleration/deceleration lanes, shoulders, islands, tapers, or other incidentals shall not be considered for price adjustments. If grinding is required due to failure to meet the required profile index, the pavement will be ground to a level which qualifies for 100% payment. The IRI will be used to determine acceptance for Pavement Smoothness and Incentives/Disincentives for each 0.1 mile segment.

**Incentives/Disincentives for Pavement Smoothness.** Incentive payments will be shown on the final estimate as a separate item. Price adjustments apply to the total area of final surface for the standard lane width represented by the IRI for a continuous mainlane section at least 0.1 mile (200 m) in length. Areas less than 0.1 mile (200 m) shall be combined with a full 0.1 mile segment. Any area less than 0.1 mile (200 m) shall be authorized by the Engineer prior to the profiling activities. Incentives will be calculated based on the following guidelines.

<b>INTERNATIONAL ROUGHNESS INDEX</b>		<b>PERCENT OF CONTRACT UNIT PRICE</b>
<b>in/mi/0.1 Mi</b>	<b>mm/km/200 m section</b>	
60 or less	940 or less	+6.0%
Over 60 to 65	Over 940 to 1025	+4.0%
Over 65 to 70	Over 1025 to 1100	+2.0%
Over 70 to 75	Over 1100 to 1180	0
Over 75 to 80	Over 1180 to 1260	-2.0%
Over 80 to 85	Over 1260 to 1340	-4.0%
<b>Over 85</b>	<b>Over 1340</b>	<b>CORRECTIVE WORK REQUIRED</b>

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

CONSTRUCTION REQUIREMENTS AND ACCEPTANCE OF

ASPHALT CONCRETE PLANT MIX COURSES

**Section 410, Construction Requirements and Acceptance of Asphalt Concrete Plant Mix Courses**, of the Standard Specifications for Highway Construction, Edition 2014, is hereby modified as follows:

**410.10 Incentives.** It is the intent of this specification to produce a pavement that is durable and consistently exceeds the minimum test values established in these specifications. To that end, incentives will be included in the pay schedule for ACHM Binder Course and/or ACHM Surface Course. Incentive pay will be according to the following guidelines.

When the entire quantity of either the ACHM Binder Course or ACHM Surface Course (including any sublots used for leveling) meets the following criteria, an incentive of the percentage designated will be applied to the dollar amount for all the components of the designated mix. For the purpose of incentives, the only tests to be considered shall be the average test results for each lot. Incentive payments will be accomplished by Change Order and will be shown on the final estimate as a separate item increase. An accumulated maximum 6.0% incentive payment is available as follows:

- (a) An incentive payment of 3.0% will be added if:
- the asphalt binder content is within  $\pm 0.2$  percentage point of the mix design value, and
  - the total variation, low to high, in air voids is no more than 0.5%, with none outside of the compliance limits, and
  - all densities fall between 92.5%\* and 96.0%, and
  - there are no areas of segregation outside of the compliance limits as verified by testing according to Subsection 410.09(b)(3), and
  - the VMA are within the compliance limits

\*When the minimum specification density is 90.5%, this value is changed to 90.5%.

(b) An additional incentive payment of 3.0% will be added if the total ACHM Surface Course quantities used on the project will be added if:

- the pavement smoothness incentive criteria are met, and
- all sublots or replacement sublots qualify for full payment, and
- there are no corrective patches\* or grinding.

\*Note: Any repaved section of 1000' (300 m) or greater in length for a full lane width will not be considered a patch.

The pavement surface smoothness and associated payment incentives will be determined by the use of the Inertial Profiler (IP) and the International Roughness Index (IRI). Pavement smoothness will be determined for each lane by obtaining the IRI for the left and right wheel paths in an individual lane. The difference in the left and right wheel path shall not exceed 5% for each tenth mile segment. After the

final ACHM surface has been placed, the averaged IRI value will be used to determine payment incentives.

**Equipment and Operator.** The Contractor shall furnish a properly calibrated IP, capable of exporting raw profile data in an unfiltered ERD file format and an approved ADF file format. The IP shall also produce a profilogram (profile trace of the surface tested). The IP shall conform to the Class I requirements of the most recent revision of ASTM E950.

Profile analysis for determination of IRI and areas of localized roughness will be conducted using ProVAL version 3.6 or the most recent version of ProVAL Software. IRI values shall be reported in inches/mile (in/mi).

The Contractor shall furnish an operator, trained in the operation of the particular IP and knowledgeable in the use of the most recent version of the ProVAL software.

**Pavement Surface Testing.** In the presence of the Engineer, the Contractor shall setup a test section to calibrate the distance sensor and check the profile system calibration before each day's testing. Unless otherwise authorized by the Engineer, all smoothness testing shall be performed in the presence of the Engineer. For the duration of the work, every reasonable effort shall be made to test smoothness within 5 working days after each day's run. Scheduling and testing shall be coordinated with the Engineer. The Engineer and the Contractor shall mutually agree upon scheduling of smoothness testing so the testing can be observed. Any testing performed without the Engineer's presence, unless otherwise authorized, may be ordered rerun at the Contractor's expense.

The Contractor shall remove all objects and foreign material on the pavement surface prior to surface evaluation. The Contractor will be responsible for all traffic control associated with testing and any corrective work (when applicable) that is required of the final pavement surface.

The IP shall be run in the direction of traffic. Profiles shall be measured in the left and right wheel paths of each lane. Each lanes' wheel path shall be tested and evaluated separately. The Engineer shall determine the length in miles for each mainlane of traffic. The IP shall be operated at the optimum speed as defined by the manufacturer.

The Contractor shall profile the final surface of the entire job length to determine total incentive. Intermediate lifts will not be eligible for incentive, but may be profiled to isolate rough areas requiring proactive grinding. The Engineer will verify the profiles by testing approximately 10% of the pavement. This testing will be performed by the Engineer, using either the IP furnished by the Contractor or one provided by the Department, at the option of the Engineer.

The difference in the left and right wheel path shall measure no more than 5.0% of the averaged left and right wheel path. When any of the segments on the left or right wheel path differs by more than 5.0% of the corresponding averaged wheel path reading, the segment shall be ground to a differential of 5.0% or less. If the differential exceeds 5%, then the project will not qualify for incentive, even if IRI requirements have been achieved.

The averaged IRI values for all segments will be used to determine payment incentive. The right and left wheel path readings will be averaged for every point read during the 528' lane segment. Areas less than

0.1 mile (200 m) shall be combined with a full 0.1 mile segment before profiling. The left and right averaged wheel path points will be averaged to obtain an IRI value for the lane segment.

**Submittals.** The Contractor shall submit the printed profilogram (graphical trace) signed by the operator, indicating each tenth mile segment’s averaged IRI value, to the Engineer on the same day the profiling is conducted.

The Contractor shall also submit electronic files in ERD and ADF format that represent the raw data from each pass. The electronic file names shall follow the standardized format shown below. Electronic ERD and ADF files that do not follow this standardized naming convention will not be accepted.

YYMMDD-J-T-N-D-L-W-S

Where:

- YY=Two-digit year
- MM=Month (including leading zeros)
- DD=Day of Month (including leading zeros)
- J=the Department Job Number
- T=Route Type (I, AR, US, etc.)
- N=Route Number (no leading zeros) and auxiliary ID (if applicable, i.e. E, W)
- D=Primary route direction (I or D, indicating Increasing or Decreasing; Increasing = North or East, Decreasing = South or West)
- L=Lane number (1 for driving lane, increasing by one for each lane to the left)
- W=Wheel path (L (left), R (right), or B (both))
- S=Beginning Station

Price incentives will be calculated as follows:

(% Price Incentive) x (Composite Unit Price of ACHM Surface Course/Ton) x (Tons of ACHM Surface Course, in Final Lift)

Incentives will be calculated based on the following guidelines.

	0% in/mi (m/km)	1% in/mi (m/km)	2% in/mi (m/km)	3% in/mi (m/km)
Percent of Contract Unit price	60-55 (<0.95)	55-50 (<0.87)	50-45 (<0.79)	≤45 (<0.71)

