

WYOMING DEPARTMENT OF TRANSPORTATION  
SUPPLEMENTARY SPECIFICATION  
FOR  
PAVEMENT SMOOTHNESS FOR PLANT MIX PAVEMENT

This Supplementary Specification replaces Section 401.0399 - SURFACE TOLERANCES of the 1993 edition of the Standard Specifications For Road and Bridge Construction.

**DESCRIPTION:** This Supplementary Specification establishes standards for the smoothness of plant mix pavement.

**EQUIPMENT:** Equipment to measure profile analysis and determine the Profile Index (PI) may be a California-type profilograph or a one or two sensor inertial profiler meeting the requirements of ASTM E 950-94.

The testing apparatus to conduct pavement smoothness analysis and determine the International Roughness Index (IRI) shall meet the requirements of ASTM E 950 - 94 and shall be equipped with a two sensor laser profilometer and an automated photo triggering device. The equipment shall be capable of measuring PI and IRI simultaneously while traveling up to a speed of 50 mph.

Milling equipment shall be a power operated machine equipped with a 30 foot mobile reference (ski). The milling machine shall have a drum with a triple scroll micro-milling pattern and shall be operated at a slow forward speed to ensure that the scroll pattern is not overrun. Milling and grinding equipment shall have a positive means of controlling cross slope elevations. The milling or grinding operation shall be continuous to produce the best overall pattern. Grinding equipment shall be capable of establishing a profile grade by referencing from either the existing pavement or from an independent grade control.

**CONSTRUCTION:** Transverse pavement smoothness, parking lot pavement and approach pavement, and other locations as determined by the Engineer, will be tested using a 10-foot straightedge. The variation of the surface from the testing edge of the straightedge, between any two contacts with the surface, shall not exceed 3/16-inch. Deviations in excess of 3/16-inch in 10 feet will require corrective action.

Longitudinal pavement smoothness will be tested and evaluated using profile analysis and pavement smoothness analysis. The profile analysis is measured using Profile Index (PI) and is the basis for identifying areas requiring corrective action. The

pavement smoothness analysis is measured using the International Roughness Index (IRI), based on a quarter-car simulation and is the basis for determining pay adjustments.

Certification:

– Driver Certification

Operators performing pavement smoothness and profile analysis testing with an inertial profiler shall have a current certification from the Wyoming Materials Technician Certification Program. Certifications are valid for a period of 3 years. Proof of certification shall be available at each job site for visual inspection by the Engineer.

– Vehicle Certification

Each inertial profiler vehicle shall pass certification by the Department in accordance with the applicable procedure in the Materials Testing Manual. Each vehicle shall be certified annually prior to the construction season. The Materials Program will affix a decal to certified vehicles which will specify the date of certification, the expiration date, and the initials of the Department representative who certified the vehicle. Proof of vehicle certification shall be available for visual inspection by the Engineer.

Exemptions:

Profile analysis testing will be required on all pavement placed, excluding shoulders as shown on the plans. The following locations will be exempt from pavement smoothness analysis for quality acceptance; however, they shall be measured for profile analysis and corrective action:

- Structures - 15 feet either direction from a defined structure. A structure is defined as an approach slab, bridge end (if no approach slab is present), at-grade reinforced concrete box, cattle guard, railroad crossing, or manhole. Structures will not be included, even if they receive a lift of plant mix on this Contract or have previously received an overlay;
- Ramps, including tapers;
- Acceleration and deceleration lanes, including tapers;
- Entrance and exit tapers for climbing lanes. The entrance taper will begin where

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the transition into the climbing lane begins and will end at the point where the climbing lane is full width as shown on the plans. The exit taper will begin where the climbing lane is full width, as shown on the plans, and the transition begins to taper out of the climbing lane;

- Horizontal curves 900 feet or less in centerline radius from 165 feet prior to the P.C. to 165 feet following the P.T.;
- Roadways posted at speed limits of less than 40 mph;
- Beginning and ending of paving limits - 15 feet either side of the transverse tie-in joint at the project paving limits where the proposed plant mix pavement ties into the existing plant mix pavement;
- Road segments that are less than 0.01 miles in length.
- Road segments within 100 ft of a stop sign on the mainline.

**Profile Analysis:**

The Contractor shall conduct the profile analysis testing under the supervision of the Engineer for determination of corrective action locations. The Contractor shall provide two working days notice to the Engineer prior to testing. The Contractor shall set the triggering devices or paint marks to delineate the locations where profile analysis testing begins and ends, 15 feet outside the project paving limits and at defined structures. If a defined structure is overlaid, the pavement across the structure will be measured for profile analysis and corrective action. Photo-triggering devices, as recommended by the manufacturer, shall be used with inertial profiling equipment and paint marks may be used for California-type profilographs. Placement of these triggering devices or marks will be reviewed and approved by the Engineer prior to profile analysis testing. Locations of triggering devices shall be marked by indelible means. If the Contractor elects to perform profile analysis testing under traffic, the testing shall be conducted at 50 mph  $\pm$  2 mph or at the posted speed limit  $\pm$  2 mph, whichever is less.

Profile analysis testing may be conducted by the Contractor as directed by the Engineer on the plant mix pavement surface before the placement of the cover seal coat or the plant mix wearing course and on the plant mix wearing course surface. Testing shall be conducted in the direction of traffic flow and in each wheel path of each mainline traffic lane measured 3 feet from the lane edge or centerline unless otherwise shown on the plans. The Contractor shall determine and delineate the corrective action location(s) and make the corrective action(s) required to meet the

specification as approved by the Engineer.  
 Corrective action will be required as determined by the testing equipment in accordance with the following table:

Posted Speed Limit	Surface Type	Maximum Surface Deviation
Greater than 40 mph	- plant mix surface to receive a cover seal coat	0.4 inches in 25 feet or less
	- surface of plant mix wearing course	0.4 inches in 25 feet or less
	- plant mix surface to receive a plant mix wearing course	0.5 inches in 25 feet or less
Less than or equal to 40 mph	- all plant mix surfaces	0.7 inches in 25 feet or less

Deviations in excess of these tolerances or those shown above for transverse surface tolerance will require corrective action. On plant mix surfaces to receive a plant mix wearing course, the pavement shall be tested for profile analysis and corrective measures made prior to placement of the plant mix wearing course.

Except on plant mix wearing course surfaces, the Contractor shall core locations requiring corrective action prior to repairing the surface deviation. If the core indicates that the newly placed pavement thickness is inadequate to allow grinding and maintain design thickness within 1/2-inch as shown on the plans, or if the surface deviation is a dip, the defective area of pavement shall be removed and replaced at no additional expense to the Department. Plant mix material placed at any location receiving additional material shall be a minimum of 1 1/2 inches thick unless the material being replaced is plant mix wearing course. Corrective action required on the surface prior to cover seal coat or plant mix wearing course placement shall be repaired with milling, diamond grinding or removal and replacement of the plant mix pavement. Corrective action required on the surface of plant mix wearing course shall be repaired using diamond grinding, a pre-approved mill, or removal and replacement of the plant mix wearing course. The State Construction Office will be responsible for approval of a triple scroll micro-mill for use on plant mix wearing course. This approval will be made based on equipment demonstration on a wearing course surface.

The vertical difference between adjacent peaks and valleys of the milled or ground

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surface shall not exceed 1/8-inch. Milling and diamond grinding shall be conducted parallel to the travel lanes unless otherwise approved by the Engineer.

Milling and grinding operations shall not adversely affect roadway drainage. Shoulders shall be repaired with the same method as the adjacent travel lane repair for drainage purposes and the safety of the traveling public.

Surfaces that have been milled or ground shall have a plain seal coat and a sand cover applied with the exception of surfaces that will receive a cover seal coat or plant mix wearing course before winter shutdown. The plain seal coat and the sand cover shall be placed in accordance with Section 409 - SEAL COATS of the Standard Specifications. Subsection 409.032 - WEATHER AND SEASONAL LIMITATIONS of the Standard Specifications will apply, with the exception that the seal coat dates will be waived.

Corrective work shall be completed prior to the placement of the cover seal coat or the plant mix wearing course and before winter shutdown.

Corrective work on travel lanes and adjacent shoulders, including traffic control requirements, shall be performed by the Contractor at no additional cost to the Department.

No additional work, such as placement of cover seal coat, may progress until the profile analysis report has been submitted to the Engineer and approved.

The Contractor shall submit a report to the Engineer after the initial profile analysis testing has been performed indicating areas requiring corrective action and a separate report indicating that no additional corrective action is required after the corrective action has been completed. These reports shall indicate the following information:

- Project number;
- Project roadway designation and section description;
- Date the test was performed;
- Name(s) of the test operator(s);
- Identification of the type and brand of testing equipment;
- The direction of travel;

- A summary of locations where corrective action is required designated by roadway station; and
- A graphic profile of the testing measurements.

Pavement Smoothness Analysis:

Pavement smoothness analysis testing shall be performed by the Contractor under the supervision of the Engineer following corrective action and prior to the placement of the cover seal coat or following corrective action, if required, on the plant mix wearing course. The Contractor shall provide 2 working days of notice to the Engineer before the completion of the corrective action. The Contractor shall conduct pavement smoothness testing within 2 working days after the completion of corrective action as approved by the Engineer. The Contractor shall remove loose material and debris from the roadway before the pavement smoothness analysis testing. The removal of loose material will not be measured and paid for separately and will be considered subsidiary to the plant mix pavement bid item being tested.

The pavement smoothness analysis testing shall be conducted in both wheel paths for the full length of pavement placed to determine the IRI and shall be conducted separately from profile analysis testing. The full length of the pavement placed shall be divided into road segments to calculate IRI. A road segment is defined as a single paved travel lane, including climbing lanes, passing lanes, and turning lanes, at the width shown on the plans, and 0.01 to 0.10 miles in length. The initial road segment shall begin 15 feet inside the paving limits.

The Contractor shall place the photo triggering devices on the roadway shoulder at the beginning and ending limits of locations exempt from the pavement smoothness analysis testing. The photo triggering device shall be a device as specified by the equipment manufacturer. Placement of these triggering devices will be reviewed and approved by the Engineer prior to pavement smoothness analysis testing. Locations of triggering devices shall be marked by indelible means.

The test vehicle shall travel at a speed of  $50 \pm 2$  mph or at the posted speed limit  $\pm 2$  mph, whichever is less, throughout the road segment(s) being tested. The vehicle shall be driven without sudden braking, acceleration, or stopping, or the test shall be void. The testing run shall begin 300 feet before the beginning of the first road segment and continue at least 300 feet beyond the end of the last road segment. For each test, the roadway shall be tested in a single pass of the projects entire paved limits. Three pavement smoothness analysis tests shall be taken on each road segment for quality acceptance.

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Control

Pavement smoothness analysis testing shall not be conducted when it is raining or if water is standing on the road. No compensation will be allowed the Contractor for delays in testing caused by adverse weather.

Prior to processing the test information, the data obtained from the exempt locations shall be eliminated from the data set. The following information shall be developed from the remaining data:

- IRI for each pavement smoothness analysis test per road segment based on averaging the IRI for each wheel path;

$$IRI_{ij} = \frac{IRI_{il} + IRI_{ir}}{2}$$

$IRI_{ij}$  = Average IRI for each pavement smoothness analysis test per road segment.

$IRI_{il}$  =  $IRI_{ij}$  for the left wheel path.

$IRI_{ir}$  =  $IRI_{ij}$  for the right wheel path.

$i$  = pavement smoothness analysis test number; i.e., 1, 2, or 3.

$j$  = road segment number.

- IRI of each pavement smoothness analysis test for the full length of pavement placed under the contract;

$$IRI_i = \frac{\sum_{j=1}^n IRI_{ij} \times L_{ij}}{\sum_{j=1}^n L_{ij}}$$

$IRI_i$  = IRI for each pavement smoothness analysis test for the project.

$IRI_{ij}$  = Average IRI for each pavement smoothness analysis test per road segment.

$L_{ij}$  = Length of the associated road segment.

$i$  = pavement smoothness analysis test number; i.e., 1, 2, or 3.

$j$  = road segment number.

$n$  = total number of road segments on the project.



$StDev(IRI)$  = Average project standard deviation.  
 $StDev(IRI_j)$  = Standard deviation of the IRI's of each road segment for each pavement smoothness analysis test.

Data processing and report preparation shall be performed by the Contractor and submitted to the Engineer indicating the following information based on the pavement smoothness analysis testing for acceptance:

- Project number;
- Project roadway designation and section description;
- Date the test was performed;
- Name(s) of the test operator(s);
- Identification of the test vehicle;
- Identification of the type and brand of test equipment;
- The location of each road segment tested, including the direction of travel;
- The  $L_j$  of each road segment for each test measurement;
- The  $IRI_{ij}$  for each test measurement per road segment;
- The  $IRI_i$  for each road segment;
- The  $StDev(IRI_i)$  of each road segment for each test measurement;
- The  $Avg(IRI)$  for the project; and
- The  $StDev(IRI)$  for the project.

This information shall be provided within 2 working days of the pavement smoothness analysis testing. The assessment value will be determined by the Engineer.

No additional work, such as placement of a cover seal coat, may progress until the pavement smoothness analysis report has been submitted to the Engineer and approved.

If the entire final course of plant mix pavement or plant mix wearing course is not

placed before winter shutdown, data shall be obtained for any portion of the roadway in which the final course of pavement has been placed. The data shall be combined with the data collected when the project is completed for determining the final pay assessment.

#### VERIFICATION AND DISPUTE RESOLUTION

At anytime during the course of the paving operation, the Department may perform independent ride quality testing for verification. If the verification testing results produce an average IRI that differs from the Contractor's by more than 5 in/mi, or if the standard deviation differs from the Contractor's by more than 3 in/mi, then the Department and Contractor will attempt to resolve the differences. If a resolution can be mutually agreed upon, it shall be documented in the Engineer's project file.

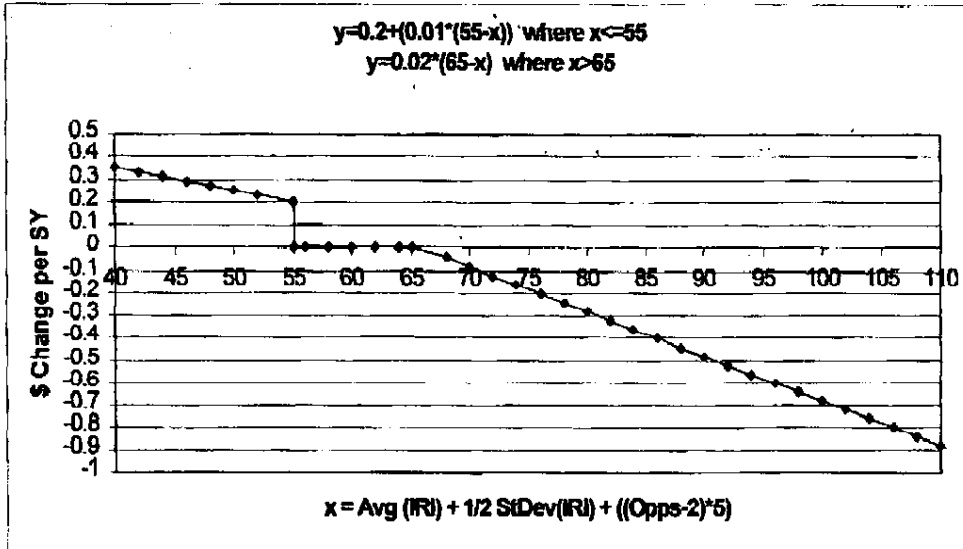
If a resolution cannot be mutually agreed upon, then referee testing will be conducted by a mutually agreed upon third party. Referee testing will be conducted using an inertial profiler that has been recently certified in accordance with the Materials Testing Manual.

If the testing confirms the Department's profiler, then the Contractor's profiler shall be taken out of service until it has been re-certified in accordance with the Materials Testing Manual. A similar requirement will apply if the testing confirms the Contractor's profiler.

The cost of the third party testing will be paid by WYDOT if the Contractor's profiler results are confirmed by the third party testing, and by the Contractor if WYDOT's profiler results are confirmed by the third party testing.

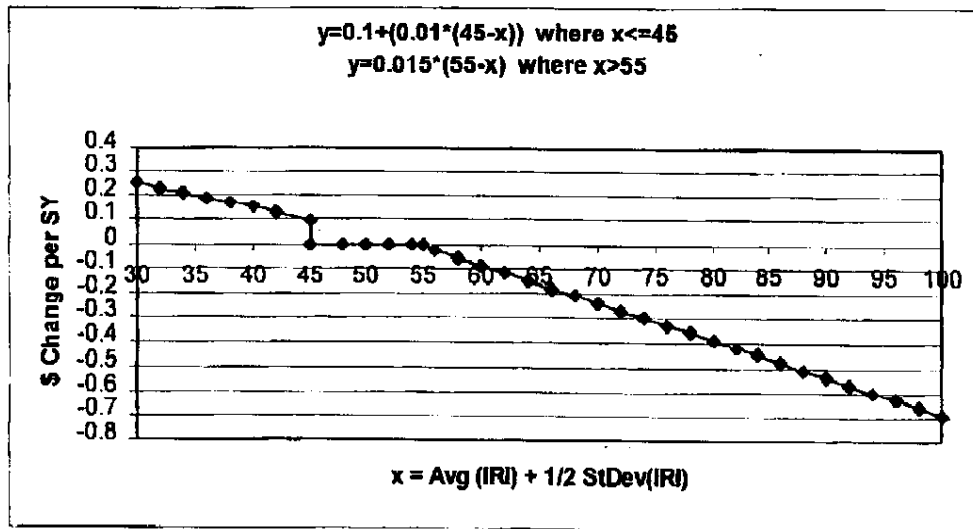
**METHOD OF MEASUREMENT:** Pavement smoothness analysis testing and IRI calculations will be performed as previously described and applied to the total surface area, in square yards, of all lanes tested. The total surface area will be the summation of the length, measured in the center of the travel lane, multiplied by the lane width, as shown on the plans, of each road segment. Pavement smoothness analysis will be measured and pay adjustments assessed for each direction of travel separately on divided highways. The Avg(IRI) and the StDev(IRI) will be used to determine the assessment value from the following applicable table:

### Assessment Value for Pavement Smoothness on Plant Mix Pavement



- Avg(IRI) = Average of IRI for all road segments.
- StDev(IRI) = Standard Deviation of the road segment average IRI's.
- Opps = Number of opportunities. Actions qualifying as opportunities include milling, leveling, and overlay lifts of 1 ½ inches or more that extend full length and full width of a road segment. The equation may vary between road segments. The maximum number of opportunities to be used in the equation will be 2.

**Assessment Value for Pavement Smoothness  
 on Plant Mix Wearing Course**



Avg(IRI) = Average of IRI for all road segments.  
 StDev(IRI) = Standard Deviation of the road segment average IRI's.

**BASIS OF PAYMENT:** Corrective action requirements will apply, and the road segments shall be repaired as specified at no additional expense to the Department. The Contractor will be assessed incentive and disincentive pay adjustments based on pavement smoothness analysis. Pay adjustments will be assessed for each direction of travel on highways with a median. On highways without a median, only one pay adjustment will apply.

$$\text{Assessment} = \text{Assessment Value} \times \text{Total Surface Area}$$

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