SECTION 401: PAVEMENT SMOOTHNESS MEASUREMENT

401.1 DESCRIPTION

This Work consists of providing and using profile testing Equipment that incorporates the Mean Roughness Index (MRI) measurement for the established categories provided within this Section.

Unless otherwise specified in the Contract, category one (1) Table 401.5.1.1:1, "MRI Based Profile Pay Adjustment Schedule for Category I HMA/WMA Projects," will be applicable to all Hot Mix Asphalt (HMA)/Warm Mix Asphalt (WMA) Projects. Unless otherwise specified in the Contract, Table 401.5.1.2:1, "MRI Based Profile Pay Adjustment Schedule for Category I PCCP Projects" will be applicable to all Portland Cement Concrete Pavement (PCCP) Projects.

This specification applies to all construction Projects, with one (1) opportunity for pavement smoothness. An example of one (1) opportunity for pavement smoothness is a single lift of paving operations for HMA/WMA or PCCP.

401.2 MATERIALS—Reserved

401.3 CONSTRUCTION REQUIREMENTS

401.3.1 Profile Measurements

Collect raw profile data utilizing profiler settings used in certification by TTCP "Certification of Intertila Profilers." Export all raw profile data to create files conforming to the University of Michigan Transportation Research Institute's Engineering Research Division (ERD) format using an upper wavelength cutoff filter of 300 ft for HMA/WMA. For PCCP data collection use a Butterworth Band-Pass filter short cutoff wavelength of seven (7.0) ft and a long cutoff wavelength of 300 ft, and the current calibration documentation to the accompanying Department representative, within one (1) hour after the data has been collected, on either a CD or Universal Serial Bus (USB) memory storage device. Provide additional data files or text files upon request. If the Contractor does not submit the profile measurements files within this time period, the Department may alter the Pay Adjustments resulting from Table 401.5.1.1:1, "MRI Based Profile Pay Adjustment Schedule for Category I HMA/WMA Projects", Table 401.5.1.1:2 "MRI Based Pay Adjustment Schedule for Category II HMA/WMA Projects", Table 401.5.1.2:1, "MRI Based Profile Pay Adjustment Schedule for Category I PCCP Projects", or Table 401.5.1.2:2, "MRI Based Profile Pay Adjustment Schedule for Category II PCCP Projects" by applying an additional five percent (5%) price deduction of the total price reduction for the Profiled area in question.

401.3.1.1 Profile Measurement Device

Provide, operate, and maintain a profile measurement device that uses Equipment and computer programs in accordance with AASHTO M 328 "Inertial Profiler", or an equal approved by the State Materials Bureau.

401.3.1.2 Profile Measurement Device Calibration and Certification

Certify the profile measurement device in accordance with the Department's *Standard Practice "Certification of Inertial Profilers"*. Profile measurement devices used for Acceptance testing on NMDOT Projects shall have a current TTCP annual calibration sticker or manufacturer's calibration and certification certificate. The manufacturer's certificate is valid only until the date of the next TTCP sponsored profile measuring device certification.

Verify calibration of the profile measurement device. Verify both horizontal and vertical calibration before each use. Perform verifications in the presence of the Department's representative as determined by the Project Manager and in accordance with the manufacturer's approved procedures and maintain copies of the verification documentation

and manufacturer's procedures with the machine and provide the calibration documentation and verification documentation to the Project Manager. The Project Manager may require additional calibrations or verifications.

Remove the profile measurement device from the Project if it does not meet manufacturer's calibration requirements. The Project Manager will report the TTCP profile measurement device certification number to the TTCP Administrator in order to provide notification that the Contractor cannot use the machine on other Projects until the Contractor obtains re-certification. Once the manufacturer re-certifies the profile measurement device, provide a copy of the certificate to the Department's TTCP Administrator. The TTCP Administrator will provide a temporary TTCP certification valid until the next scheduled certification.

401.3.1.3 Technician Certification

The Department's TTCP will certify individuals performing profile measurement. The Department will base certification on demonstrated ability and a written test. The TTCP will establish the term and expiration date of certification and requirements for renewal. The Department State Materials Engineer, through the TTCP, will investigate any concerns submitted in writing as to the competence of a certified individual and implement corrective action if necessary in accordance with the TTCP Board of Directors established procedures.

401.3.1.4 Profile Measurement Operations

The Department will consider profile testing as part of the paving operation. Include the proposed frequency and schedule for profile testing with the paving plan submittal at the pre-paving conference. Allow the Department's Representative to witness the collection of raw data by riding in the vehicle while collecting the data.

Obtain the Project Manager's written approval and sweep the Roadway surface before beginning profile operations.

Final surface is the surface immediately behind the paving operation prior to any surface modification.

Measure the longitudinal smoothness of the final surface of HMA, WMA, OGFC, and PCCP using a Department certified profile measurement device. Operate the profile measurement device in accordance with AASHTO R 57 "Operating Inertial Profiling Systems" and manufacturer's recommendations. Using dual-sensors, with single point lasers or bar lasers one (1.0) inch or less, measure the profile traces for each wheel path. Locate outside trace three (3) feet from and parallel to the approximate location of the pavement edge line. Ensure the centerline distance between sensors is 70.0 inches ± one (1.0) inch. At transverse joints, commence profile traces at the joint location. Operate the device on the driving surface of the Roadway at the manufacturer's recommended speed without interfering with traffic or its own operation.

On HMA/WMA Projects, perform profile measurements and corrective actions on the final surface of HMA/WMA. On PCCP Projects, perform profile measurements and corrective actions on the finished surface after tining or grooving.

Maintain the profile data files. Take additional profiles to retest paved surfaces that have received corrective Work. The Project Manager may require additional profiles to check previously submitted data or to identify the limits of surface irregularities. Include the following information for each data file:

1. Project number,
2. Date,
3. Lane profiled,
4. Beginning and ending stations,
5. Net total linear feet of each lane,

6. Filter settings, and
7. Operator's signature.

401.3.1.5 ProVal Profile Data Analysis by the Department

The Department will use the FHWA's current version of "ProVal" software to determine the MRI for each 0.1 mile section of each lane, reported to the nearest 0.1 inch per mile using the average of the two wheel paths' IRI's, using Ride Quality Analysis. Using the ProVal software, the Department will not use any further filter settings. Do not use the 250 mm filter in "ProVal". Data obtained through analysis by the Department will be used for evaluations of all "Must Grind Work", "Corrective Work", and "Pay Adjustments."

401.3.2 Straightedge Measurements (Category III)

Test the final surface of HMA, WMA, or PCCP with an approved ten (10) foot straightedge at both right angles and parallel to the centerline, advancing the straightedge in five (5) foot increments. In lieu of a physical ten (10) foot straightedge measuremet and at the direction of the Project Manager a profile measurement device that complies with Section 401.3.1.1 "Profile Measurement Device" can be used for the ten (10) foot straightedge measurement. Correct surface deviations greater than 1/8 inch within ten (10) ft, as directed by the Project Manager.

401.3.3 Evaluation for Must Grind Work and Corrective Work

Evaluate the pavement in 0.1-mile sections for determining needed Must Grind Work, Corrective Work and Pay Adjustments.

401.3.4 Diamond Grinding

Diamond grinding equipment uses diamond tipped saw blades, composed of industrial diamonds and metallurgical powder, that are gang mounted on a cutting head ranging in width from 36 inches to 48 inches. The diamond grinding equipment shall use water to cool the cutting head. The slurry or residue resulting from the grinding operation shall be contiuously removed from the pavement with a wet vacuum process. The slury or residue shall not be allowed to flow across lanes occupied by traffic or to flow into gutters or other drainage facilities. Diamond grinding equipment shall be self-propelled, self-contained and without external attachments acting as cutting / grinding devices.

Diamond grinding operations shall not dislodge aggregate or binder creating rock pockets or deviations on pavement surface.

401.3.5 Must Grind Work

Identify potential must grind locations using "Ride Quality Analysis" under the "Analysis Type" with the "Continuous" feature of the latest version of the FHWA's "ProVAL" software. Use a MRI threshold (inch/mi) of 105.00 and a segment length of 25.00 feet. Identify must grind locations for each lane using the "MRI" Ride Quality Index feature of ProVAL. Any locations with a MRI of 105.00 to 125.00 will be evaluated by the Project Manager and the Contractor, to determine if diamond grinding is required, final determination will be made by the Project Manager. All locations with an MRI above 125.00 must be included in the corrective action plan.

Develop and submit an appropriate written corrective action plan, including methods and procedures utilized to diamond grind and achieve the specified MRI values proposed by the Contractor, to the Project Manager for review and written approval. Do not begin must grind Work until the Project Manager approves the methods and procedures in writing. Failure to submit and obtain approval of the corrective action plan will result in the contractor correcting all locations identified by ProVAL regardless of the smoothness value for the 0.1 mile section. The Project Manager's approval does not relieve the Contractor of the responsibility to comply with the Specifications.

Correct all must grind locations on the Project identified by the approved written corrective action plan then measure and evaluate Roadway profiles for smoothness Pay Adjustment. Use diamond grinding to bring the reported average measured smoothness value to an acceptable level.

Do not reduce planned pavement thickness by more than 0.3 inches without written approval of the Project Manager.

Grind must grind areas across the lane width to produce a smooth transition to the surrounding pavement. If the must grind area is not the full width of the lane, only half of the lane containing the roughness shall be ground and smoothly feathered into the surrounding pavement.

For HMA/WMA, if the Contract does not require an OGFC, or OGFC will not be placed before Project suspension, apply a fog seal to the ground areas as approved by the Project Manager. Fog seal and all operations necessary to apply it is included in the Bid Item Unit Price for HMA/WMA, the Department will make no separate payment.

401.3.6 Corrective Work

Develop and submit an appropriate written Corrective Work Plan, including methods and procedures, utilized to diamond grind and achieve the specified MRI values proposed by the Contractor, to the Project Manager for review and written approval if the measured smoothness value falls within the "Corrective Work Required" (CWR) value of the applicable pay adjustment table and category as indicated in the Contract. If approved, complete elected corrective Work, including necessary traffic control, at no additional cost to the Department. After completion of the approved corrective Work, re-profile the corrected area to verify compliance with specification requirements.

Limit corrective Work to diamond grinding, overlaying, or removing and replacing rejected 0.1-mile sections. Do not begin corrective Work until the Project Manager approves the methods and procedures in writing. The Project Manager's approval does not relieve the Contractor of the responsibility to comply with the Specifications.

Perform corrective Work in accordance with the following:

1. Surface Diamond Grinding. Use diamond grinding to bring the measured smoothness value to an acceptable level in accordance with the applicable table(s) and category(ies) as indicated in the Contract.

   Do not reduce planned pavement thickness by more than 0.3 inches without written approval of the Project Manager.

   Grind corrective Work areas to produce a smooth transition to the surrounding pavement. If the corrective Work areas are not the full width of the lane, only half of the lane containing the corrective Work area shall be ground and smoothly feathered into the surrounding pavement.

   For HMA/WMA, if the Contract does not require an OGFC, or OGFC will not be placed before Project suspension, apply a fog seal to the ground areas as approved by the Project Manager. Fog seal and all operations necessary to apply will be Incidental to the Bid Item Unit Price for HMA/WMA; the Department will make no separate payment.

   For PCCP, perform additional diamond grinding as necessary in the following situations:

   1.1. The transverse direction, so the lateral diamond grinding limits are at a constant offset from and parallel to the nearest lane line or pavement edge; and

   1.2. The longitudinal direction, so the diamond grinding begins and ends at lines perpendicular to the pavement centerline. Maintain diamond grinding locations as neat rectangular areas of uniform appearance. If tining is eliminated by

diamond grinding, machine groove the hardened concrete in the same pattern as adjacent tining at no additional cost to the Department.

2. Overlaying. If the Contractor uses an additional lift of HMA/WMA to correct rough pavement, the HMA/WMA shall meet the requirements of the appropriate specification. Extend the overlay lift the full width of the underlying pavement surface to a finished compacted thickness sufficient to correct the existing pavement roughness.

   The Department will not allow a second overlay if the first overlay does not meet the longitudinal smoothness requirement.

   Correct a corrective overlay that does not meet the smoothness requirement by diamond grinding or removing and replacing as specified in Section 401.3.6 “Corrective Work”.

3. Removing and Replacing. Remove pavement the full width of the lane and the full thickness of the course. The removal area shall begin and end with a transverse saw cut perpendicular to centerline. Use the type of approved HMA, WMA or PCCP as originally specified in the Project Contract as replacement Material.

Re-profile the 0.1 mile section of travel lane after performing corrective Work and use the re-profile’s reported measured smoothness data to represent the particular section for Pay Adjustment purposes.

401.3.7 OGFC Placement and Profile Measurement

Ensure HMA/WMA profile measurements and corrective Work has been completed before placing OGFC. Pay Adjustment will be based on the MRI of the HMA/WMA unless the measured MRI of the OGFC is greater than the measured MRI of the HMA/WMA on the same 0.1 mile section, then the Department will base the Pay Adjustment for the HMA/WMA section on the OGFC’s measured MRI.

401.4 METHOD OF MEASUREMENT

The Department will determine smoothness Pay Adjustments on the calculated square yards of the surface area of the travel lane bound by the plan typical section travel lanes and 0.1-mile lane length.

401.5 BASIS OF PAYMENT

Surface smoothness testing and corrective Work to bring the final surface within specification smoothness in accordance with the applicable table(s) and category(ies) as indicated in the Contract is Incidental to the Bid Item Unit Price for HMA, WMA or PCCP; the Department will make no separate payment. All traffic control required to determine and correct pavement smoothness is Incidental to the HMA, WMA or PCCP item.

All adjustments of manhole and utility valves for the facilitation of pavement smoothness shall be performed after paving of the finish grade. This Work shall be paid in accordance with Section 662 “Manholes” and 663 “Utility Items.”

401.5.1 Pay Adjustments

The Department will calculate a Pay Adjustment for each 0.1 mile section of travel lane. The Pay Adjustments will apply to the total accepted area of each 0.1 mile section of HMA, WMA or PCCP constructed for the plan typical section travel lane width and Roadway length.

The Department will not include Shoulder and turnout areas for payment purposes.

If the Pay Adjustment for a 0.1 mile section is not equal to CWR but less than 0.00, the Contractor shall accept the designated Pay Adjustment.

401.5.1.1 Pay Adjustment for Category I and Category II HMA/WMA Projects

The Department will base Pay Adjustments on the final MRI for each 0.1 mile section in accordance with Table 401.5.1.1:1, "MRI Based Profile Pay Adjustment Schedule for Category I HMA/WMA Projects" and Table 401.5.1.1:2, "MRI Based Profile Pay Adjustment Schedule for Category II HMA/WMA Projects", after the Contractor performs and measures corrective Work.

Table 401.5.1.1:1
MRI Based Profile Pay Adjustment Schedule
for Category I HMA/WMA Projects

Pay Adjustment ($ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category I
<52.1			0.00
52.1	to	53.0	-0.14
53.1	to	54.0	-0.28
54.1	to	55.0	-0.42
55.1	to	56.0	-0.56
56.1	to	57.0	-0.70
57.1	to	58.0	-0.84
58.1	to	59.0	-0.98
59.1	to	60.0	-1.12
>60.0			Corrective Work Required

Table 401.5.1.1:2
MRI Based Profile Pay Adjustment Schedule
for Category II HMA/WMA Projects

Pay Adjustment ($ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category II
<62.1			0.00
62.1	to	63.0	-0.12
63.1	to	64.0	-0.24
64.1	to	65.0	-0.36
65.1	to	66.0	-0.48
66.1	to	67.0	-0.60
67.1	to	68.0	-0.72
68.1	to	69.0	-0.84
69.1	to	70.0	-0.96
70.1	to	71.0	-1.08
71.1	to	72.0	-1.20
72.1	to	73.0	-1.32
73.1	to	74.0	-1.44
>74.0			Corrective Work Required

401.5.1.2 Pay Adjustment for PCC Pavement

The Department will base Pay Adjustments on the final average MRI for each 0.1 mile section in accordance with Table 401.5.1.2:1, "MRI Based Profile Pay Adjustment Schedule for Category I PCCP Projects" and Table 401.5.1.2:2, "MRI Based Profile Pay Adjustment Schedule for Category II PCCP Projects," after the Contractor performs and measures corrective Work.

Table 401.5.1.2:1
MRI Based Profile Pay Adjustment Schedule
for Category I PCCP Projects

Pay Adjustment ($ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category I
<59.3			0.00
59.3	to	60.2	-0.14
60.3	to	61.2	-0.28
61.3	to	62.3	-0.42
62.4	to	63.3	-0.56
63.4	to	64.3	-0.70
64.4	to	65.4	-0.84
65.5	to	66.4	-0.98
66.5	to	67.5	-1.12
>67.5			Corrective Work Required

Table 401.5.1.2:2
MRI Based Profile Pay Adjustment Schedule
for Category II PCCP Projects

Pay Adjustment ($ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category II
<65.0			0.00
65.0	to	66.0	-0.12
66.1	to	67.0	-0.24
67.1	to	68.0	-0.36
68.1	to	69.0	-0.48
69.1	to	70.0	-0.60
70.1	to	71.0	-0.72
71.1	to	72.0	-0.84
72.1	to	73.0	-0.96
73.1	to	74.0	-1.08
71.1	to	75.0	-1.20
75.1	to	76.0	-1.32
76.1	to	77.0	-1.44

Table 401.5.1.2:2
MRI Based Profile Pay Adjustment Schedule
for Category II PCCP Projects

77.1	**to**	**78.0**	**-1.56**
78.1	**to**	**79.0**	**-1.68**
79.1	**to**	**80.0**	**-1.80**
>80.0			**Corrective Work Required**