PN 420 – 1/20/2023 - SURFACE SMOOTHNESS REQUIREMENTS FOR PAVEMENTS

DESCRIPTION: The surface tolerance specification requirements are modified to use the International Roughness Index (IRI) as follows for all pavements of constant width with at least 1 centerline mile (1.6 km) of continuous paving. Short breaks in paving such as bridge decks, intersections, etc. are not considered breaks in continuous paving. Also included is pavement for ramps, including acceleration lanes and deceleration lanes, where the total length is greater than 0.5 miles (0.8 km); and all interstate-to-interstate ramps including acceleration lanes and deceleration lanes, regardless of total length.

For roads with less than 1 centerline mile (1.6 km) of paving; ramps, acceleration lanes, and deceleration lanes not included above; and sections of undivided highways, as defined in this note, within corporation limits with posted speed limits less than 40 miles per hour, smoothness measurement and corrective action for all areas of localized roughness with an IRI in excess of 250 inches per mile (3.95 m/km) in 25 feet (7.6 m) is required. For these same areas, no corrective action for 0.1-mile (0.16 km) sections having an MRI (lot roughness) greater than 90 inches per mile (1.42 m/km) is required and no pay adjustments will be made.

Do not include pavement for turn lanes including center turn lanes, shoulders, crossovers, approach slabs, and bridge decks in IRI measurements, corrective actions, and pay adjustments.

Areas not part of this specification are subject to the requirements of the original item(s) specified.

If the pavement surface is Rubberized Open Graded Asphalt Friction Course (Supplemental Specification 803), this specification applies to the surface of the course immediately below and references to the number of courses placed do not include the SS803 course.

MATERIALS AND EQUIPMENT: Provide smoothness measuring equipment conforming to Supplement 1058. Furnish the Department's approval letter of the profiler and the operator to the Engineer. The Engineer will verify the smoothness measuring equipment conforms to Supplement 1058. The Engineer will complete the Smoothness Profiler Verification Report found in Supplement 1058, Appendix A, to document profiler calibration prior to measurement. The Engineer will verify the profile operator's certification against the operator list posted on the Office of Construction Administration webpage. Furnish equipment meeting the requirements of C&MS 257.02 for performing corrective diamond grinding.

SMOOTHNESS MEASUREMENT: Measure the pavement surface smoothness in both wheel paths. Wheel paths are located parallel to the centerline or baseline of the roadway or ramp and approximately 3.0 feet (1.0 m) from the centerline of the lane or ramp, measured transversely in both directions. Ensure the path of the profiler is parallel to the lane centerline at all times. Measure the entire length of pavement, event marking the profile runs such that profile data can later be identified when the profile sensor(s) is within 1.0 foot (0.3 m) of any existing pavement not constructed on the project, pressure relief joint, approach slab, or other non-pavement

features (i.e., manholes, valve boxes, unusual geometry, catchbasins, etc.). It is the operator's responsibility to note such locations in the collected inertial profiles. Profiles provided without named event markings will not be reviewed and will be returned for correction. Non-pavement and pre-existing conditions will be considered on a project-by-project basis and approved by the Engineer for exclusion from IRI calculations.

Remove any objects such as dirt, debris, curing covers, etc., prior to performing the surface smoothness measurements. Replace any curing covers after the measurements are taken. Repair any membrane curing damaged during the measurements.

Do not perform any surface smoothness measurements until the pavement has cured sufficiently to allow measuring without damaging the pavement. When the pavement will not support the profiler on the next working day, notify the Engineer and inform the Engineer when the measurements will be taken. Provide the Engineer at least 24 hours' notice prior to performing any measurements. Do not take measurements until project site verification is demonstrated to the Engineer according to Supplement 1058.

IRI and MRI CALCULATION: Develop an IRI according to ASTM E 1926 for each 0.1-mile (0.16 km) section.

Non-pavement features and pre-existing conditions approved by the Engineer that influence the IRI measurements in a wheelpath should be sectioned out of profiles using the Leave-Out function in ProVAL for the corrective action and pay adjustment. Use 5-feet before and after length when using the Leave Out function. Do not perform corrective diamond grinding within 1.5 feet of a non-pavement feature installed directly in a wheel path.

Submit the summary report from ProVAL conforming to Supplement 1110 and electronic copies of all longitudinal pavement profiles in ProVAL compatible format to the Engineer. The Engineer will submit one copy of the summary report and one electronic copy of the profiles to the Office of Technical Services.

Provide necessary traffic control and survey stationing for all surface smoothness measurements.

MANDATORY CORRECTIVE ACTION: Perform corrective action for the applicable surface type as required. Provide a list of all mandatory corrective action locations, with station, lane, proposed corrections, proposed maximum grinding depths, and proposed final IRIs and MRIs for each location to the Engineer for approval as a Corrective Action Plan. The Corrective Action Plan is limited to grinding, pavement removal and replacement or a combination of the two. Submit the Corrective Action Plan at least 7 days prior to planning any corrective action. Corrective Action Plans that do not meet allowable IRI and MRI values at post-correction will not be approved. Do not perform any corrective actions without approval of the Engineer.

Corrective action required to meet the maximum allowable IRI and MRI values that are performed after the contract completion date will be a Punch List item in accordance with C&MS 109.12.B. Corrective action will not be assessed liquidated damages in C&MS 108.07 or contract

disincentives. If corrective action on the Punch List is not completed within a reasonable time, as determined by the Final Inspector, it will be subject to an assessment of fifty percent of liquidated damages in accordance with C&MS 109.12.B.

Upon completion of the corrective action, re-measure surface smoothness according to this specification. Replace pavement markings and raised pavement markers according to the plans. All costs for corrective action will be the responsibility of the contractor.

Asphalt Concrete Surface: Classify asphalt pavement areas into one of the following types based on the work performed as part of the Project.

Type A: Asphalt pavement specified as at least two uniform courses with the total thickness placed greater than or equal to 3 inches (75 mm).

Type B: Asphalt pavement specified as either: a) at least one uniform course with the total thickness placed less than 3 inches (75 mm) and including Item 254 or SS897 planing prior to resurfacing, or b) at least two uniform courses with the total thickness less than 3 inches (75 mm) without including Item 254 or SS897 planing prior to resurfacing.

Type C: Asphalt pavement specified as a single uniform course not meeting the criteria of Type B. The uniform course may be placed on a non-uniform leveling course.

TABLE 420-1 ASPHALT CONCRETE PAVEMENT CLASS CRITERIA

	Divided Highways*		**Undivided Highways***	
Pavement Class	Corrective Action	Pay Adjustment Schedule (Table 420-3)	Corrective Action	Pay Adjustment Schedule (Table 420-3)
Type A [≥ 3in. + 2-course]	[1],[5]	A	[2],[5]	A
Type B [< 3in. + Milling] or [< 3in. + 2-course]	[1],[5]	A	[3],[5]	A
Type C [< 3in. + 1-course]	[2],[5]	A	[4]	B

* Divided highways have physical separation such as a grass median, raised concrete median, guardrail, or barrier between the two directions of travel. Highways with continuous two way left turn lanes are considered undivided. Undivided highways with short sections, less than 1000 feet (300 m), of physical separation are considered undivided for the entire length.

Corrective Action:

[1] Correct all areas of localized roughness having deviations, high or low points, with an IRI in excess of 160 inches per mile (2.53 m/km) in 25 feet (7.6 m).

[2] Correct all areas of localized roughness having deviations, high or low points, with an IRI in excess of 200 inches per mile (3.16 m/km) in 25 feet (7.6 m).

[3] Correct all areas of localized roughness having deviations, high or low points, with an IRI in excess of 225 inches per mile (3.55 m/km) in 25 feet (7.6 m).

[4] Correct all areas of localized roughness having deviations, high or low points, with an IRI in excess of 250 inches per mile (3.95 m/km) in 25 feet (7.6 m).
[5] Correct any 0.1-mile (0.16 km) sections having an MRI greater than 90 inches per mile (1.42 m/km).

Perform corrective action as required in Table 420-1. Do not propose diamond grinding corrections in excess of one-third the contract Item surface course thickness. When removal is required for corrective action, remove the entire asphalt course(s) affected, for the full lane width, for a minimum length of 30 feet, and replace per the original contract item(s). Apply Item 407 Tack Coat prior to placing any asphalt concrete. Do not diamond grind more than 5 percent by longitudinal length of the lane-miles (lane-km) eligible for a pay adjustment. Feather ground areas to provide a smooth surface.

Re-measure each 0.1-mile (0.16 km) section where corrective action was performed to ensure compliance with Table 420-1.

If the final surface course is Item 803, seal any diamond ground areas with material meeting the requirements of 702.04 prior to placing the Item 803.

Portland Cement Concrete Surface: Classify pavement areas into one of the following types based on the work performed as part of the Project.
Type A: Concrete pavement with the total specified thickness greater than or equal to 8 inches (200 mm).
Type B: Concrete pavement with the total specified thickness greater than 6 inches (150 mm) and less than 8 inches (200 mm).
Type C: Concrete pavement with the total specified thickness less than or equal to 6 inches (150 mm).

TABLE 420-2 PORTLAND CEMENT CONCRETE PAVEMENT CLASS CRITERIA

	Divided Highways*		**Undivided Highways***	
Pavement Class	Corrective Action	Pay Adjustment Schedule (Table 420-3)	Corrective Action	Pay Adjustment Schedule (Table 420-3)
Type A [≥ 8in.]	[1],[5]	A	[1],[5]	A
Type B [> 6 in. & < 8in.]	[1],[5]	A	[2],[5]	A
Type C [< = 6 in.]	[2],[5]	A	[3]	B

* Divided highways have physical separation such as a grass median, raised concrete median, guardrail, or barrier between the two directions of travel. Highways with continuous two way left turn lanes are considered undivided. Undivided highways with short sections, less than 1000 feet (300 m), of physical separation are considered undivided for the entire length.

Corrective action:

[1] Correct all areas of localized roughness having deviations, high or low points, with an IRI in excess of 160 inches per mile (2.53 m/km) in 25 feet (7.6 m).

[2] Correct all areas of localized roughness having deviations, high or low points, with an IRI in excess of 200 inches per mile (3.16 m/km) in 25 feet (7.6 m).

[3] Correct all areas of localized roughness having deviations, high or low points, with an IRI in excess of 225 inches per mile (3.55 m/km) in 25 feet (7.6 m).

[5] Correct any 0.1-mile (0.16 km) sections having an MRI greater than 90 inches per mile (1.42 m/km).

Perform corrective action as required in Table 420-2 by diamond grinding or removing and replacement per the original contract items. Feather ground areas to provide a smooth surface.

Re-measure each 0.1-mile (0.16 km) section where corrective action was performed to ensure compliance with Table 420-2.

Complete all corrective action prior to determination of pavement thickness. If corrective action is required, the surface texture after diamond grinding is acceptable and no additional texturing is required.

Asphalt and Portland Cement Concrete Surfaces: If corrective action is required, develop a Corrective Action Plan as specified in the Mandatory Corrective Action section of this Specification. Upon completion of the corrective action, re-measure surface smoothness according to this specification. In the event the Contractor was not able to correct the surface smoothness to meet the Specification, deductions will be made according to *Post-Correction Pay Adjustment* procedures below.

METHOD OF MEASUREMENT: Determine the IRI for each lane, for each wheel path, for each 0.1-mile (0.16 km) section of paving. The MRI for a 0.1-mile (0.16 km) section is the average of the IRI of the two wheel paths.

PAY ADJUSTMENTS: A lump sum pay adjustment will be made according to the following schedule and calculations for each lane for each 0.1-mile (0.16 km) section. Payment will be based on a 12 foot (3.7 m) lane width, regardless of lane width. Pay adjustments are based on the weighted average bid unit cost per square yard for the section multiplied by the pay factor as determined in Table 420-3. Pavement thickness is the total thickness of asphalt concrete, Portland cement concrete, or both placed as part of the contract and does not include any SS803 course, free draining base, aggregate base, stabilized subgrade, etc.

TABLE 420-3 PAY SCHEDULE			
SCHEDULE A		**SCHEDULE B**	
MRI	**PAY ADJUSTMENT**	**MRI**	**PAY ADJUSTMENT**

Inches per mile per 0.1 mile section (m/km per 0.16 km section)	Percentage of Unit Cost (PUC) (%)	Inches per mile per 0.1 mile section (m/km per 0.16 km section)	Percentage of Unit Cost (PUC) (%)
35 (0.55) or less	4	45 (0.71) or less	4
Over 35 to 50 (0.55 to 0.79)	$(50 - IRI) * (\frac{4}{15})$	Over 45 to 60 (0.71 to 0.95)	$(60 - IRI) * (\frac{4}{15})$
Over 50 to 70 (0.79 to 1.10)	0	Over 60 (0.95)	0
Over 70 to 90 (1.10 to 1.42)	$-(IRI - 70) * (\frac{6}{20})$		
Over 90 (1.42)	(1)		

(1) Corrective action required

Asphalt Pavements:

$$WUC = \frac{(t_1 \times u_1) + (t_2 \times u_2) + (t_3 \times u_3) \ldots}{36}$$

Where: *WUC = weighted unit cost ($/SY). t = lift thickness (in.).*
$u = bid\ unit\ cost$ *($/CY).*

Concrete Pavements:

WUC = bid unit cost ($/SY)

Pay Adjustment *(PA)*:

$$PA = WUC \times 704 \times PUC$$

Where: WUC = weighted unit cost ($/SY).
PUC = percentage of unit cost from Table 420-3, expressed as a decimal.

Pay adjustments will be based on the measured IRI of each wheelpath and averaged as MRI, after any mandatory corrective action, however no incentive will be paid for any 0.1-mile (0.16 km) section where mandatory corrective action was performed regardless of the resulting IRI/MRI. No pay adjustments will be made for sections less than 0.1 miles (0.16 km) long, however corrections for localized roughness are required.

At the Contractor's option, corrective action may be performed on any section with an MRI greater than 70 inches per mile (1.10 m/km) to reduce or eliminate the negative pay adjustment, however no incentive will be paid regardless of the resulting MRI. As an option the Department may allow corrective action, in the form of diamond grinding, Item 254, or SS897 pavement planing, to improve the profile on any course prior to the surface course. If the final course is Item 803 do not

perform corrective action on the Item 803. Only diamond grinding may be performed on the course immediately below Item 803.

POST-CORRECTION PAY ADJUSTMENT

Lot Roughness: Any uncorrected 0.1 mile (0.16 km) section at post-correction, subject to Schedule A, with an MRI of 90.1 or greater will require a negative pay adjustment according to the following table. Remove and replace any uncorrected 0.1 mile (0.16 km) section with an MRI greater than 95.

MRI at post-correction	% Pay Adjustment
90.1	20
91	35
92	51
93	67
94	84
95	91
>95	Remove and replace

Localized Roughness: Any section of uncorrected localized roughness up to 10% over the specified IRI threshold and subject to Schedule A or B, will require a negative pay adjustment based on the localized roughness analysis using the weighted average bid unit cost per square yard for the section being assessed. The following formula will be used to determine the negative pay adjustment per violation.

Negative Pay Adjustment, per wheel path = Length of Violation x IRI above Threshold x WUC

The minimum negative pay adjustment will be $500.00 per wheel path per violation. Negative pay adjustments for uncorrected localized violations are cumulative for each wheel path.

Remove and replace locations with uncorrected localized roughness greater than 10% of the specified IRI. Replace the entire lane width per violation.

BASIS OF PAYMENT: Include the cost of all labor, equipment, and materials necessary to meet this specification in the contract unit or lump sum price for the applicable pavement items.

Designer Notes: This note should be used on all paving projects at least 1 centerline mile (1.6 km) long (both divided and undivided highways). Undivided highway sections totally within corporation limits should be excluded.

The designer should consider clarifying in the plans which locations are considered divided highways and which are undivided highways according to the definition in the note if there is any chance of misinterpretation.

If there are any questions on the use or application of this note contact:

Dan Radanovich – Division Planning, Office of Technical Services (614-351-2878)
Construction Pavement Engineer – Division of Construction Management, Office of Construction Administration (614-466-3165)