

Section 2316. Pavement Smoothness.

2316.01 GENERAL.

Pavement smoothness shall be evaluated for all Interstate and Primary main line pavement surfaces, and all other road surfaces included on Primary projects, except when specifically excluded by the contract documents. Pavement smoothness shall not be evaluated for all other roads unless specified in the contract documents. Main line pavement is defined as all permanent pavement for traffic lanes, including tapers to parallel lanes or through lanes at intersections, tapers to climbing lanes, and tapers to ramps and loops. Pavement smoothness shall also be evaluated for all interchange ramps and loops.

If this specification is required by contract documents on non-Primary projects let by the Department, it will be added in its entirety. Selected portions of the specification will not be deleted.

Bridge approach sections which are a part of the paving contract will be tested for smoothness.

A. Smoothness Requirements.

The following shall apply to all Interstate and Primary projects, and to non-Primary projects when specified. Smoothness requirements in inches per mile (millimeters per kilometer) are listed in Schedules A and B. On lanes over 8.5 feet (2.6 m) in width, for through traffic which requires matching the surface of the new pavement to the surface of an existing old pavement, an Average Base Index (ABI) will be calculated as shown below; this will be the smoothness base in inches per mile (millimeters per kilometer) for payment for the new pavement unless otherwise specified. The requirements are shown in Schedule C.

Schedule for Identification of Pavements And Bridge Approach Sections		
<u>Pavement</u>	Schedule By Posted Speed (mph) <u>(Existing or Proposed)</u>	
	45 or less	Over 45
Mainline, curbed (one or both sides of roadway)	B	A
Mainline, not curbed	A	A
Ramps and Collector Distributor Roads	A ⁽³⁾	A ⁽³⁾
Loops	B	B
Side Roads	B	A
Grade Separations ⁽¹⁾	B	A
Pavement adjacent to existing pavement (added lane)	C ⁽²⁾	C ⁽²⁾
<p>(1) Including municipal and Secondary Roads therein. (2) $ABI = \frac{PI + X}{2}$ Where, PI = the profile index of the edge line of the abutting lane. If the computed ABI is less than X, use an ABI equal to X. X = 7 inches/mile (110 mm/km) if Schedule A, or 22 inches/mile (350 mm/km) if Schedule B.</p> <p>(3) When a ramp or collector distributor road terminates at an intersection with a traffic signal or stop sign, the 700 feet (215 m) nearest the intersection will be evaluated under Schedule B.</p>		

B. Exclusions.

Areas excluded from smoothness testing are detour pavement, crossovers, shoulders, and sections less than 50 feet (15 m) long.

All excluded areas will be checked with a surface checker by the Engineer and shall not exceed 1/8 inch in 10 feet (3 mm in 3 m).

2316.02 MEASUREMENT.

The Contractor shall provide and operate a California type profilograph to determine the pavement profile in accordance with [Materials I.M. 341](#). Other types of profilographs or profilers that produce compatible results and meet the requirements of [Materials I.M. 341](#) may be used.

When a pavement, for which smoothness is to be tested is adjacent to an existing old pavement, smoothness must also be tested on the old pavement 3 feet (1 m) from the adjacent edge for ABI calculation. Should the surface of the old pavement be specified for correction, smoothness testing for ABI calculation shall be done after correction.

All objects and foreign material on the pavement surface, including protective covers, if used, shall be removed by the Contractor prior to testing, and if appropriate, protective covers shall be properly replaced by the Contractor after testing.

A profilogram shall be made for each segment of 50 feet (15 m) or more. The profilogram shall include the 16 feet (5 m) beyond the ends of the section.

A. Pavements.

The pavement surface will be divided into sections that represent continuous placement. A section will terminate at a day's work joint (header), a bridge, similar interruption, or when continuous placement crosses to a section with a different smoothness designation. Sections longer than 778 feet or 0.147 miles (240 m) placed without interruption will be separated into segments of 0.1 mile (160 m). The terminating segment may be shorter than 0.1 mile (160 m) and greater than 250 feet (80 m) and is still considered a segment. A segment is to be in only one traffic lane. Each traffic lane will be tested and evaluated separately. Gaps in otherwise continuous sections, for temporary crossings, or similar construction sequencing, will be tested, when placed, and included in the adjacent section evaluation.

B. Bridge Approach Sections.

Bridge approach sections shall be tested with the profilograph. Each lane of each approach shall be an individual segment and shall not be considered a part of a pavement segment, section, or project. Testing shall be at the center of each traffic lane of travel.

2316.03 PROFILOGRAPH TESTING.

The Contractor shall perform testing and furnish the profilogram results to the Engineer. The testing and evaluation shall be done by a trained and certified person, and the evaluation shall be certified in accordance with [Materials I.M. 341](#).

A. Pavements.

Each segment shall be tested and evaluated. The profile trace and index for each segment of paving shall be furnished to the Engineer by noon of the next day worked following the placement until there has been 3 consecutive days of paving where the index for all segments would result in 100% payment or better. After 3 consecutive days of paving that qualify for at least 100% payment, the profile trace and index must be furnished to the Engineer within 48 hours after each day's run. Should any following day be evaluated to receive less than 100% payment, a trace and index shall be furnished to the Engineer by noon the following day worked for each day until there has been 3 consecutive days of 100% payment or better.

For each day's run, an evaluation shall be submitted to the Engineer within 5 working days. This evaluation submittal shall include identification of segments that may qualify for less than 100% payment, segments that may qualify for incentive payment, segments to be corrected, and the section weighted average in inches per mile (millimeter per kilometer) certified smoothness testing.

The Engineer may also subject the surface to monitor testing. Any portion of the project may be tested if the Engineer determines that the Contractor certified test results are inaccurate. If they are inaccurate, the Contractor will be charged for this work at a rate of \$250 per lane per mile (\$150 per lane per kilometer), with a minimum charge of \$500. In addition, furnishing inaccurate test results could result in decertification.

B. Bridge Approach Sections.

Bridge approach sections shall be tested and evaluated.

2316.04 PROFILE INDEX.

A. Pavement.

A profile index shall be calculated for each segment from the profilogram in accordance with [Materials I.M. 341](#) except for:

1. Side road connections less than 600 feet (180 m) in length.
2. Single lift pavement overlays 2 inches (50 mm) or less in thickness unless the existing surface has been corrected by milling or scarification.
3. Storage lanes and turn lanes.
4. Pavement less than 8.5 feet (2.6 m) in width.
5. The 16 feet (5 m) at the ends of the section when the Contractor is not responsible for the adjoining surface.
6. Runout tapers on HMS overlays at existing pavement, bridges, or bridge approach sections when the thickness is less than the design thickness.

If there is a segment of 250 feet or 0.047 mile (80 m) or less in length at the end of a section, the profilograph measurements for that segment shall be added to and included in the evaluation of the adjacent segment in that section.

Bumps and dips shall be separately identified on all profilograms. These appear as high or low points on the profilogram and correspond to high points (bumps) or low points (dips) on the pavement surface. They are identified by locating vertical deviations exceeding 0.5 inches for a 25 foot (13 mm for a 7.6 m) span for both bumps and dips as indicated on the profilogram.

B. Bridge Approach Sections.

A profile index shall be calculated for each bridge approach section in accordance with [Materials I.M. 341](#) except for plan lengths less than 50 feet (15 m) which will be checked for bumps and dips only.

2316.05 SURFACE CORRECTION.

Surface correction for pavement smoothness may be required which includes bumps or dips. The correction shall be completed before the determination of pavement thickness.

Bump, dip, and smoothness correction work shall be for the full lane width of the paved surface.

All correction work shall be subject to the approval by the Engineer. After all required correction work is completed, the final profile index shall be determined.

A. Pavements.

1. Portland Cement Concrete Pavement.

PCC pavement surface correction shall be accomplished by grinding the pavement using a diamond grinder, by PCC resurfacing, or by replacement. Grinding and texturing equipment shall meet the requirements of [Section 2532](#), except the cutting head shall have a minimum width of 24 inches (600 mm). Surface correction shall be performed parallel to lane lines or edge lines as directed by the Engineer and each pass shall be parallel to the previous passes. The ground surface shall be of uniform texture.

Adjacent passes shall not overlap more than 1 inch (25 mm) and they shall not have a vertical difference of more than 1/8 inch (3 mm) as measured from bottom of groove to bottom of groove. Smoothness correction shall begin and end at lines normal to the pavement lane lines or edge lines within any one corrected area. The grinding shall proceed from the center line or lane line toward the pavement edge to maintain pavement cross slope.

2. Hot Mix Asphalt Pavements.

For asphalt pavements, the surface correction shall be accomplished by diamond grinding, by overlaying the area, by replacing the area, or by inlaying the area.

If the surface is corrected by diamond grinding, the work and equipment shall be the same as specified for PCC pavement except that the ground surface shall be covered with a seal coat as described in [Article 2303.03, B, 2](#), for a runout.

If the surface is corrected by overlay, replacement or inlay, the surface correction shall begin and end with a transverse saw cut normal to the pavement lane lines or edge lines within any one area. Profile of surface must be smooth with no bumps or dips at beginning or end of correction. Overlay correction must be for the entire pavement width. Pavement cross slope must be maintained through the corrected areas.

B. Bridge Approach Sections.

Surface correction of bridge approach sections shall be accomplished by grinding or other approved methods. This work shall be as identified in [Section 2532](#).

The area requiring correction shall be ground full lane width.

2316.06 BUMPS AND DIPS.

Bumps and dips, including those at headers, on all pavements for which pavement smoothness is designated shall be evaluated. Correction work will be required in accordance with the following criteria and in areas excluded from profilograph testing, for deviations exceeding 1/8 inch in 10 feet (3 mm in 3 m).

A. Bumps.

For all pavements evaluated under Schedule A, all bumps exceeding 0.5 inch (13 mm) within a 25 foot (7.6 m) span, as indicated on the profilogram, shall be corrected except as stated in [Article 2316.06, C](#). On all pavements evaluated under Schedule B the bumps shall be corrected except when otherwise allowed by the Engineer and as stated in [Article 2316.06, C](#).

Corrected bumps will be considered satisfactory when measurement by the profilograph shows that the bumps are 0.3 inch (8 mm) or less in a 25 foot (7.6 m) span. For all bumps under Schedule B not corrected, the Contractor will be assessed a price adjustment for each bump over 0.5 inch (13 mm) except as stated in [Article 2316.06, C](#).

When a lane over 8.5 feet (2.6 m) in width, for through traffic, is constructed adjacent to an existing old pavement, bump correction or price adjustment to the Contractor for a bump will not apply if a bump exists at that location in the adjacent existing old pavement.

B. Dips.

On all pavements, dips of 0.5 inch to 1.0 inch (13 mm to 25 mm) in a 25 foot (7.6 m) span, as indicated on the profilogram, shall be corrected when required by the Engineer. The Contractor will be assessed a price adjustment for dips of 0.5 inch to 1.0 inch (13 mm to 25 mm) that are not corrected except as stated in [Article 2316.06, C](#). The Contractor will be required to replace the pavement in areas with dips over 1.0 inch (25 mm). Corrected dips will be considered satisfactory when the profilogram shows the dips are less than 0.3 inch (8 mm) in a 25 foot (7.6 m) span.

When a lane over 8.5 feet (2.6 m) in width is constructed adjacent to an existing old pavement, correction of a dip or price adjustment to the Contractor for a dip will not be required if a dip exists at that location in the adjacent existing old pavement.

C. Exceptions.

When the Contractor is not responsible for the adjoining pavement, bumps and dips exceeding 0.5 inches (13 mm) located within 16 feet (5 m) either side of the end of a section will be evaluated by the Engineer. The Contractor will not be price adjusted for bumps and dips in this area. When instructed by the Engineer to repair these bumps and dips, the Contractor will be paid in accordance with [Article 1109.03, B](#).

2316.07 SMOOTHNESS.

The smoothness of pavements will be compensated by the addition (incentive) or the subtraction (price reduction) of a

determined amount for each segment of pavement to the price bid for pavement. These amounts are identified in the appropriate schedule of [Article 2316.08](#).

A. Pavement Where Schedule A Smoothness is Required.

For the appropriate categories of highway, as shown in Schedule A, incentives for pavement smoothness will be paid for each segment of pavement with an initial index per mile (kilometer) per segment of 3.0 inches (48 mm) or less.

A second incentive will also be paid for each segment in a section if all segments in the section qualify for 100% payment with no grinding.

If all segments in a project qualify for 100% payment with no grinding, a third incentive will be added to the amount paid per segment.

For segments with an initial index of 7.1 to 10.0 inches per mile (110.1 mm/km to 160 mm/km), the Contractor may grind the surface to a final index of 7.0 inches per mile (110 mm/km) per segment or receive a price reduction.

For segments with an index of 10.1 inches per mile (160.1 mm/km) and greater, the Contractor shall grind the surface to a final index of 7.0 inches per mile (110 mm/km) or less.

B. Pavement Where Schedule B Smoothness is Required.

For all highways, incentives for pavement smoothness will be paid for each segment of pavement with an initial index of 12 inches per mile (190 mm/km) per segment or less.

For all segments with an initial index of 22.1 to 30.0 inches per mile (350 mm/km to 470 mm/km), the Contractor may grind the surface to a final index of 22.0 inches per mile (350 mm/km) per segment or receive a price reduction.

For segments with an index of 30.1 inches per mile (470.1 mm/km) and greater, the Contractor shall grind the surface to a final index of 22.0 inches per mile (350 mm/km) or less.

C. Pavement Adjacent to Existing Pavement.

For each segment of new pavement 8.5 feet (2.6 m) or more in width, and over 600 feet (180 m) in length, which is to be matched to the surface of an existing pavement, smoothness will be evaluated by the Average Base Index (ABI) as defined in [Article 2316.01, A](#) or [B](#).

Surface correction is required for smoothness exceeding ABI + 12 (190) when Schedule A is required and exceeding ABI + 30 (470) when Schedule B is required. Payment will be based on results after correction in accordance with Schedule C.

Areas not included in the profilograph test shall be checked longitudinally with a 10 feet (3 m) straight edge and the surface shall not deviate from a straight line by more than 1/8 inch in 10 feet (3 mm in 3 m). If correction is necessary, it shall meet requirements of [Article 2316.05](#).

D. Bridge Approach Sections.

Where Schedule A or Schedule B smoothness is required, bridge approach sections shall be constructed to an index of not greater than 22.0 inches per mile (350 mm/km). If the original surface does not meet this criteria, the surface shall be ground to an index of 22.0 inches per mile (350 mm/km) or better.

Smoothness of bridge approach sections will not be used in the calculations for incentive or price reduction of pavement segments, sections, or the project.

2316.08 SCHEDULE OF PAYMENT.

For each traffic lane of main line pavement and each traffic lane of interchange ramps and loops evaluated for smoothness, as defined in [Article 2316.01](#), the Engineer will determine the length of each segment in miles (kilometers).

For roadways, the Contractor may receive an incentive payment or be assessed a price reduction based on the number of qualifying segments and the initial profile index.

Pavement segments excluding repair work that are subject to profilograph testing, as defined in [Article 2316.04](#), will be considered for additional payment as a smoothness incentive or price reduction. For a segment to be qualified for incentive, there must be no grinding within that segment.

Surface correction (grinding) of bridge approach sections, and as stated in [Article 2316.06, C](#), will not count as surface correction on adjacent pavement segments and will not detract from possible incentive payments on those segments.

Single lift pavement resurfacing 2 inches (50 mm) or more in thickness that have milling or scarification of the original pavement, shall be rated using the multi-lift schedules.

A \$900 price adjustment shall be assessed for each dip not corrected in each pavement lane under Schedule A and B except as stated in [Article 2316.06, C](#). In addition, a \$900 price adjustment will be assessed for each bump not corrected under Schedule B except as stated in [Article 2316.06, C](#). Bumps and dips not corrected will also be included in the evaluation for the segment smoothness.

The cost of certified smoothness and associated traffic control shall be incidental to the cost of the pavement.

These payments or assessments will be based on the following schedules:

A. Schedule A Smoothness Requirements.

Pavement segments which are designated for Schedule A smoothness will be evaluated for incentive or price reduction assessments as follows:

INCENTIVES FOR PAVEMENT SMOOTHNESS						
INITIAL PROFILE INDEX	SINGLE LIFT PAVEMENTS (5)			MULTI-LIFT PAVEMENTS (8)		
	Interstate & Multi-Lane Divided Primary (2)	All Other Primary (3)	Non-Primary (4)	Interstate & Multi-Lane Divided Primary (6)	All Other Primary (6)	Non-Primary (7)
Inches Per Mile (mm/km) Per Segment (1)	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment
0-1.0	650	550	200	300	200	75
1.1-2.0	550	450	150	250	150	50
2.1-3.0	450	350	100	200	100	25
3.1-7.0	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price
(0-16)	650	550	200	300	200	75
(16.1-32)	550	450	150	250	150	50
(32.1-48)	450	350	100	200	100	25
(48.1-110)	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price

(1) For each segment of pavement that has an initial index, within the limits listed, with no grinding, the Contractor will receive an incentive payment as shown in the tabulation for the appropriate category.

(2) If all segments in a section of pavement in this category qualify for 100% payment with no grinding, the qualifying incentive payment will be increased by \$100 per segment for each .

(3) If all segments in a section of pavement in this category qualify for 100% payment with no grinding, the qualifying incentive payment will be increased by \$75 per segment for each segment in the section.

(4) If all segments in a section of pavement in this category qualify for 100% payment with no grinding, the qualifying incentive payment will be increased by \$50 per segment for each segment in the section.

(5) If all segments in a project qualify for 100% payment with no grinding, the qualifying incentive payment as indicated in notes (2), (3), and (4) will be increased by \$50 per segment for each segment in the project.

(6) If all segments in a section of pavement in this category qualify for 100% payment with no grinding, the qualifying incentive

payment will be increased by \$25 per segment for each segment in the section.

(7) If all segments in a section of pavement in this category qualify for 100% payment with no grinding, the qualifying incentive payment will be increased by \$10 per segment for each segment in the section.

(8) If all segments in a project qualify for 100% payment with no grinding, the qualifying incentive payment as indicated in notes (6) and (7) will be increased by \$25 per segment for each segment in the project.

PRICE REDUCTION FOR PAVEMENT SMOOTHNESS

Initial Profile Index	Single Lift Pavements			Multi-Lift Pavements		
	Interstate & Multi-Lane Divided	All Other Primary	Non-Primary	Interstate & Multi-Lane Divided	All Other Primary	Non-Primary
Inches Per Mile (mm/km) Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment
3.1-7.0	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price
7.1-10.0 ⁽¹⁾	Grind or 300	Grind or 200	Grind or 100	Grind or 150	Grind or 100	Grind or 50
10.1 & Over ⁽²⁾	Grind Only	Grind Only	Grind Only	Grind Only	Grind Only	Grind Only
(48.1-110)	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price
(110-160) ⁽¹⁾	Grind or 300	Grind or 200	Grind or 100	Grind or 150	Grind or 100	Grind or 50
(160.1 & Over) ⁽²⁾	Grind Only	Grind Only	Grind Only	Grind Only	Grind Only	Grind Only

(1) For segments with an initial index of 7.1 to 10.0 (110.1 to 160), the Contractor may grind the surface to a final index of 7.0 (110) or better or accept a price reduction for each segment of pavement in non-compliance equal to the amount shown for the appropriate category.

(2) For segments with an initial index of 10.1 (160.1) and over, the Contractor shall grind the surface to a final index of 7.0 (110) or better. In lieu of grinding the surface to a final index of 7.0 (110) or better, the Contractor may elect to replace part or all of the segment.

B. Schedule B Smoothness Requirements.

Pavement segments for which Schedule B smoothness is designated and which is indexed in segments greater than 50 feet (15 m), will be evaluated for incentive or price reduction as follows.

For individual segments shorter than 50 feet (15 m), properly corrected if required, no price reduction assessment will be made.

INCENTIVES FOR PAVEMENT SMOOTHNESS

Initial Profile Index	New Pavements	Resurfaced Pavements
Inches Per Mile (mm/km) Per Segment ⁽¹⁾	Dollars Per Segment	Dollars Per Segment
0 - 4.0 (0 - 60)	600	300
4.1 - 8.0 (65.1 - 130)	500	250
8.1 - 12.0 (130.1 - 190)	400	200
12.1 - 22.0 (190.1 - 350)	Unit Price	Unit Price

(1) For each segment of pavement that has an initial index, within the limits listed, with no grinding, the Contractor will receive an incentive payment as shown in the tabulation for the appropriate category.

PRICE REDUCTION FOR PAVEMENT SMOOTHNESS

Per Segment Index	New Pavements	Resurfaced Pavements
Inches Per Mile (mm/km) Per Segment	Dollars Per Segment	Dollars Per Segment
12.1 - 22.0 (190.1 - 350)	Unit Price	Unit Price
22.1 - 30.0 ⁽¹⁾ (350.1-470)	Grind or 500	Grind or 250
30.1 & over ⁽²⁾ (470.1 & over)	Grind Only	Grind Only

(1) For segments with an initial index of 22.1 to 30.0 (350.1 to 470), the Contractor may grind the surface to a final index of 22.0 (350) or better or accept a price reduction for each segment of pavement in non-compliance equal to the amount shown for the

appropriate category.

(2) For segments with an initial index of 30.1 (470.1) and over, the Contractor shall grind the surface to a finish index of 22.0 (350) or better. In lieu of accepting a price reduction and grinding the surface to a final index of 22.0 (350) or better the Contractor may elect to replace part or all of the segment.

C. Pavement Adjacent To Existing Pavement.

For new pavement which has been matched to an existing old pavement for which an Average Base Index (ABI) was calculated, the pavement will be evaluated for a price reduction for each segment based on Schedule A or Schedule B payment.

SCHEDULE C		
INITIAL PROFILE INDEX or PROFILE INDEX AFTER CORRECTION		
(Schedule A) Inches Per Mile (mm/km) Per Segment	(Schedule B) Inches Per Mile (mm/km) Per Segment	Dollars Per Segment
0 to ABI	0 to ABI	0
ABI + 0.1 (0.1) to ABI +4 (65) incl.	ABI + 0.1 (0.1) to ABI + 10 (160) incl.	300
ABI + 4.1 (65.1) to ABI +8.0 (130) incl.	ABI + 10.1 (160.1) to ABI + 20 (315) incl.	500
ABI + 8.1 (130.1) to ABI +12 (190) incl.	ABI + 20.1 (315.1) to ABI + 30 (470) incl.	800

D. Bridge Approach Sections.

Bridge approach sections shall be corrected for smoothness as specified in [Article 2316.07](#), in lieu of a price reduction.