

SECTION 334

PAVEMENT SMOOTHNESS

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334.01 SCOPE

This specification applies to the final lift of newly placed asphalt concrete pavement. Smoothness requirements and Basis of Payment shall conform to the following specification unless otherwise indicated in the contract documents.

334.02 REFERENCES

Reference standards shall be the latest revision at the date of Tender closing. This specification refers to the following standards, specifications or publication:

- ASTM E950 "Standard Test Method for Measuring the Longitudinal Profile of Travelled Surfaces with an Accelerometer Established Inertial Profiling Reference"

334.03 DEFINITIONS

Roadway Smoothness Category: The smoothness category that applies for a particular section of roadway will be classified as either Category A, Category B or Category C. The category will be defined in the tender documents and are determined based on a number of factors, including but not limited to: roadway classification, geometry and the presence of other physical features that may influence the ability to achieve pavement smoothness as determined by the Owner's Representative.

International Roughness Scale (IRI): IRI is a statistical measurement used to determine the amount of roughness in a measured longitudinal profile. IRI shall be measured in mm/m and reported to two decimal places for all procedures relating to this specification.

Opportunities to Improve Pavement Smoothness: The Contract shall include at least two opportunities for the Contractor to improve smoothness. The first opportunity must be a new lift of asphalt with a minimum thickness greater than or equal to $3 \times$ the nominal aggregate size. Other opportunities include an additional underlying asphalt lift of sufficient thickness, levelling course, cold planning, pulverization, gravelling and cold in place recycling.

If there is only one opportunity to improve smoothness (a single surface lift over an existing pavement), the IRI of the existing pavement shall be measured. If the IRI of the existing asphalt is less than 3.00 mm/m (obtained within a maximum of 1 calendar year prior to overlay) than the smoothness specification will be applied.

Reporting Interval: The reporting interval for this specification shall be 100 metres for overall IRI and 10 metres for localized roughness.

Localized Roughness: Localized roughness is reported in 10 metre intervals where the IRI exceeds an established value as set out in Table 2, for a particular category.

Segment: A segment of roadway shall be defined by the full lane width (including paved shoulders) over a defined length. The segment length shall be 10 metres for localized roughness. The segment length shall be 100 metres for overall IRI, however, shorter segment length may exist as outlined in Section 334.06.04.

Project Chainage: The distance measured by the High Speed Profiler will be the only chainage deemed accurate and acceptable for the smoothness specification. This distance will be referenced to project chainage for informational purpose only.

334.04 EQUIPMENT

A Class 1 Inertial Laser Profiler, with moving average filter (high pass 90 metre and low pass 0.3 metre), shall be used for all smoothness measurements. The equipment will be installed and operated in accordance with the manufacturer's recommendations and ASTM E950.

334.05 PROCEDURES

334.05.01 Smoothness Testing

The Department will conduct smoothness testing in accordance with ASTM E950. The Department's smoothness testing results will be used in determining payment adjustments and areas requiring Corrective Work.

Smoothness testing will be carried out as soon as possible upon completion of the paving operation.

334.05.02 Profile Measurements

The Profiler will record the right and left wheel path IRI values simultaneously at 10 metre intervals. The final IRI readings will be the average of the left and right wheel path values reported at 10 metre intervals. The 100 metre interval averages will then be computed from the 10-metre interval average IRI values.

The profile measurements shall be collected in the direction of traffic. The start and end location of the measurement for each lane shall be 10 metres from the transverse construction joint. In the case of a tapered lane measurement shall commence at the location by which the full lane width occurs.

334.05.03 Exclusions

The 10 metre segment at the beginning and end of each test section will be excluded from the smoothness calculations. Bridges, underpass and overpass structures located within any 10 metre segment, including the 10 metre segments immediately before and after the structure shall be excluded from the payment adjustments.

Sections of roadway less than 500 m in length shall be excluded. Areas requiring handwork such as tapers, intersections, gore areas, aprons, etc. shall be excluded. Intersections and driveway tie-ins shall be completed after main line paving.

Individual 10 metre segments exhibiting roughness, which can be directly attributed to physical features including iron works or curb/gutter match-ins, may be excluded from payment adjustment at the discretion of the Owner's Representative.

334.06 MEASUREMENT FOR PAYMENT ADJUSTMENT

The Owner's Representative will provide the Contractor with a copy of the smoothness test results, including detailed payment adjustment summaries and Compulsory Corrective Work requirements.

334.06.01 100 Metre Segment

Payment adjustment for 100 metre segments shall be calculated based on the overall average IRI in mm/m for each 100 metre segment in each lane in accordance with Table 1.

334.06.02 Localized Roughness

With the exception of areas described in Section 334.05.03, each 10 metre segment with an IRI value greater than those shown in Table 2 shall be defined as localized roughness, resulting in negative payment adjustments. The total localized roughness payment adjustment shall be the numerical summation of all the individual localized roughness payments adjustments for the defined section of roadway.

334.06.03 Total Payment Adjustment

The total payment adjustment shall be the summation of all the individual payment adjustments for each 100 metre segment in each lane, including all localized roughness payment adjustments. If the total 100 metre segment payment adjustment is a positive value (bonus), the Contractor will be assessed the total 100 metre segment payment adjustment, and the total localized roughness payment for the defined section of roadway.

If the total 100 metre segment payment adjustment is a negative value (penalty), the Contractor will be assessed by either the total 100 metre segment payment adjustment or the total localized roughness payment adjustment, whichever results in a greater penalty to the Contractor. The two penalties shall not be applied in summation.

Example 1: 100 metre Segment (Station 7+700 – 7+800) Category B Exclusions apply in four (4) of the individual 10 metre segments (20 metre bridge + 10 metre at each end)

10 Metre Segment	IRI (mm/m)	Exclusion Applied (Y/N)	Localized Roughness Payment Adjustment (Table 2)	Average IRI over 60 metre Segment	IRI Payment Adjustment (Table 1)	Total Adjustment (for this 60m Segment)
7+700 – 7+710	0.53	N	\$0	(0.53 + 0.39 + 0.34 + 0.23 + 0.28 + 1.14 + 1.86 + 2.43 + 0.91 + 1.42)/6 = 0.53 AVG	\$470 x 6/10 = +\$282.00	+\$282.00 - \$250.00 = +\$32.00 (Bonus)
7+710 – 7+720	0.39	N	\$0			
7+720 – 7+730	0.34	N	\$0			
7+730 – 7+740	0.23	N	\$0			
7+740 – 7+750	0.28	N	\$0			
7+750 – 7+760	1.14	Y (Bridge)	\$0			
7+760 – 7+770	1.86	Y (Bridge)	\$0			
7+770 – 7+780	2.43	Y (Bridge)	\$0			
7+780 – 7+790	0.91	Y (Bridge)	\$0			
7+790 – 7+800	1.42	N	-\$250.00			

334.06.04 Segments Less Than 100 Metres

For segments less than 100 metres in length, price adjustments shall be determined from 10 metre segments that are not subject to exclusions as described in Section 334.05.03. Payment adjustments under Sections 334.06.01 and 334.06.02 shall apply to these areas based on the actual number of 10 metre segments that are not excluded. Price adjustments shall be prorated based on the number of non-excluded 10 metre segments in the 100 metre segment, as detailed in Table 1.

Example 2: 30 Metre Segment (Station 6+420 – 6+450) at the end of paving section
 Exclusion applied in one (1) of the individual 10 metre segment. The roadway is Category B.

10 Metre Segment	IRI (mm/m)	Exclusion Applied (Y/N)	Localized Roughness Payment Adjustment (Table 2)	Average IRI over 30 metre Segment	IRI Payment Adjustment (Table 1)	Total Adjustment (for this 60m Segment)
6+420 – 6+430	0.88	N	\$0			-\$250.00* (Penalty)
6+430 – 6+440	1.45	N	-250.00	(0.88 + 1.45)/2= 1.16 AVG	-\$190 x 2/10= -\$38.00	*Take whichever value is the greater penalty
6+440 – 6+450	1.65	Y (Manhole)	\$0			

Table 1
Average IRI Payment Adjustment - 100 Metre Segments

IRI (mm/m)	Payment Adjustment for each 100 metre segment in each Lane		
	Category A	Category B	Category C
0.00 – 0.10	+\$750.00	+\$950.00	+\$1010.00
0.11 – 0.20	+\$670.00	+\$860.00	+\$920.00
0.21 – 0.30	+\$580.00	+\$770.00	+\$830.00
0.31 – 0.40	+\$490.00	+\$670.00	+\$740.00
0.41 – 0.50	+\$400.00	+\$570.00	+\$650.00
0.51 – 0.60	+\$305.00	+\$470.00	+\$560.00
0.61 – 0.70	+\$205.00	+\$370.00	+\$460.00
0.71 – 0.80	+\$100.00	+\$270.00	+\$350.00
0.81 – 0.90	-\$20.00	+\$160.00	+\$260.00
0.91 – 1.00	-\$250.00	+\$50.00	+\$150.00
1.00 – 1.10	-\$490.00	-\$70.00	+\$50.00
1.11 – 1.20	-\$760.00	-\$190.00	-\$60.00
1.21 – 1.30	-\$1040.00	-\$320.00	-\$190.00
1.31 – 1.40	-\$1350.00	-\$450.00	-\$310.00
1.41 – 1.50	-\$1700.00	-\$590.00	-\$440.00
1.51 – 1.60	-\$2110.00	-\$740.00	-\$570.00
1.61 – 1.70	-\$2630.00	-\$900.00	-\$720.00
1.71 – 1.80	-\$3800.00	-\$1070.00	-\$870.00
1.81 – 1.90	-\$4690.00	-\$1260.00	-\$1040.00
1.91 – 2.00	-\$4700.00	-\$1480.00	-\$1220.00
2.01 – 2.10	-\$4700.00	-\$1720.00	-\$1430.00
2.11 – 2.20	-\$4700.00	-\$2040.00	-\$1670.00

Payment Adjustment for each 100 metre segment in each Lane			
IRI (mm/m)	Category A	Category B	Category C
2.21 – 2.30	-\$4700.00	-\$2750.00	-\$1980.00
2.31 – 2.40	-\$4700.00	-\$3290.00	-\$2670.00
2.41 – 2.50	-\$4700.00	-\$3300.00	-\$3190.00
2.51 – 3.00	-\$4700.00	-\$3300.00	-\$3200.00

Table 2
Localized Roughness Payment Adjustment - 10 Metre Segments

Roadway Classification	Localized Roughness IRI (mm/m) for 10 Metre Segment	Payment Adjustment (for each occurrence)
Category A	> 1.10	-\$250.00
Category B	> 1.40	-\$250.00
Category C	> 1.50	-\$250.00
All Categories	>3.00	-\$2500.00 or Compulsory Corrective Work

334.07 CORRECTIVE WORK

With the exception of areas defined in Section 334.05.03, all 10 metre segments with an IRI >3.00 mm/m shall be subjected to Compulsory Corrective Work or a Mandatory Penalty.

334.07.01 Mandatory Penalty

The Contractor shall be subjected to a mandatory penalty of -\$2,500.00 for each 10 metre segment with an IRI > 3.00 mm/m irrespectively of roadway classification.

The Owner's Representative reserves the right to require Compulsory Corrective Work on any of the sections with an IRI > 3.0 mm/m. In sections where Compulsory Corrective Work is required the Mandatory Penalty of -\$2,500.00 will be waived by the Department.

Based on overall smoothness results, the Department reserves the right to waive any or all Compulsory Corrective Work and enforce the Mandatory Penalty.

The Owner's Representative shall notify the Contractor of areas where Compulsory Corrective Work is required.

334.07.02 Compulsory Corrective Work Procedure

Corrective work shall consist of Removal and Replacement of the surface course of asphalt concrete. The minimum length of any repair area shall be 10 metres.

Removal and Replacement: On each of the 10 metres segments affected, the contractor shall remove (by cold planning) and replace the full width of the lane and the full depth of the surface course of asphaltic concrete pavement affected, including paved shoulders.

Asphalt Concrete Mix Requirements: The asphalt concrete mix used to construct the surface course shall conform to Sections 330, 332 and 333, as appropriate.

Incidental Corrective Work: Corrective Work may result in additional costs, including but not limited to cold planning, tack coat, additional shouldering, guide rail adjustments, re-application of pavement markings, etc. Such work shall be carried out in accordance with the Department's Specification Book and at the Contractor's expense.

Disposal of Asphaltic Concrete: Asphaltic concrete that has been removed as a result of Corrective Work undertaken by the Contractor shall become the property of the Contractor to haul, stockpile or otherwise dispose of in an environmentally acceptable manner, at the Contractor's expense.

Time Limit for Corrective Work: Corrective work shall be completed within 30 calendar days of receipt of smoothness test results, including any appeal test results. Corrective work not completed within the 30 calendar days will automatically be subjected to the Mandatory Penalty as stated in Section 334.07.01 and is still required to complete the Compulsory Corrective Work. For each 30 calendar days thereafter, the mandatory penalty will be applied.

334.07.02.01 Retesting Following Corrective Work

Retesting Following Corrective Work: After corrective work has been completed, each of the 100 metre segments containing the corrective work shall be retested, using the same profiler used in the original testing. The new IRI values will be evaluated in accordance with Section 334.06 and results shall be binding. Should the new IRI values result in another Mandatory Penalty as outlined in Section 334.07.01 the Owner's Representative still reserves the right to require Compulsory Corrective Work or can apply the mandatory penalty of -\$2,500.00 for each 10 metre segment.

Costs for Corrective Work: All costs associated with Corrective Work shall be the responsibility of the Contractor.