**SURFACE SMOOTHNESS - PAVEMENT PERFORMANCE SPECIFICATIONS**

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| Special Provision No. BITU 0011 March 2021 |

**Payment Adjustment for Surface Smoothness Based on Quality Assurance Measurements Taken by an Inertial Profiler for Contracts with Pavement Performance Specification**

**1.0 SCOPE**

This specification covers surface smoothness requirements for pavement that has a 3, 5, or 7‑year performance warranty.

**2.0 REFERENCES**

This specification refers to the following standards, specifications, or publications:

**Ministry of Transportation Publications**

LS-296 Method of Test for Calibrating, Correlating and Conducting Surface Smoothness Measurements Using an Inertial Profiler

**American Association of State Highway and Transportation Officials (AASHTO)**

M 328 Standard Specification for Inertial Profiler

R56 Standard Practice for Certification of Inertial Profiling Systems

R 57 Standard Practice for Operating Inertial Profiling Systems

**ASTM International**

E 950 Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference

**3.0 DEFINITIONS**

For the purpose of this specification, the following definitions apply:

**Existing Surface** means the original pavement surface prior to construction under the Contract.

**Inertial Profiler** means a device used for surface smoothness measurements conforming to requirements of a Class 1 Profilometer according to ASTM E 950 and meeting the additional requirements stated in LS-296.

**Initial Measurements** means the first set of three measurements taken by an inertial profiler on a given pavement section.

**International Roughness Index (IRI)** means a specific mathematical transform of a true pavement profile by means of a Quarter Car Filter where the absolute values of the vertical vibration are accumulated and divided by the sublot length. IRI is expressed in m/km.

**Micromilling** means milling equipment with a specialized milling drum fitted with carbide bits to provide the surface texture specified in this Special Provision.

**Profiler Operator** means a person who has been adequately trained by the manufacturer of an inertial profiler to operate the inertial profiler and has received a certificate of training.

**Quarter Car Filter** calculates the suspension deflection of a simulated mechanical system with a response similar to one corner (a quarter) of a passenger car travelling at 80 km/hr.

**Straight Edge** means a straight edge made of metal with a level recessed in its upper surface parallel to the lower edge.

**Surface Course** means the HMA wearing course of any flexible or composite pavement.

**Sublot** means a continuous traffic lane of pavement; excluding the shoulder, which has been measured by inertial profiler for purposes of repairs/payment adjustments and normally having a length of 100 m.

**Subsequent Measurements** means any measurements by an inertial profiler taken after the initial measurements.

**Through Lane** means a traffic lane not intended for entering or exiting the roadway and does not include shoulders. Where there is more than one roadway, through lane refers to the traffic lane for the higher-class roadway.

**Unfiltered Data File** means a data file representing the profile of a pavement surface taken by the inertial profiler before any user-controlled filtering are applied.

**Wheel Paths** mean 0.9 m on each side of the centreline of the actual trafficked lane. The trafficked lane does not include adjacent paved areas such as paved shoulders or tapers.

**4.0 DESIGN AND SUBMISSION REQUIREMENTS - Not Used**

**5.0 MATERIALS - Not Used**

**6.0 EQUIPMENT - Not Used**

**7.0 CONSTRUCTION**

**7.01 Smoothness Correction of Pavement Surface(s) Beneath Surface Courses**

At no additional cost to the Owner, unless otherwise specified in the Contract, hot mix asphalt padding may be placed on the existing pavement or any other pavement(s) underlying the surface course, in order to meet the surface smoothness requirements specified for the surface course. The hot mix padding shall be completed using an asphalt mix type acceptable to the Owner.

Diamond grinding/grooving or micromilling will also be allowed for such corrections on existing pavements or any other pavements underlying the surface course, provided such corrections do not reduce the thickness of existing pavement materials or underlying materials by more than 5 mm below the general profile of the surrounding existing unground or unmilled pavement surface. Micromilling shall not be used for concrete pavement.

**7.02 Reflector Placement**

Prior to smoothness measurements, including referee measurements, reflectors used to automatically turn on/off the profiler shall be obtained from the profiler operator and placed on the left/right shoulder or the highway median at the beginning and end of each profile run as required by the profiler operator. After smoothness measurements are completed each day, the reflectors shall be removed and returned to the profiler operator.

**8.0 QUALITY ASSURANCE**

**8.01 Surface Smoothness Lot Size**

A lot for surface smoothness shall consist of the total quantity of surface course placed as part of the Contract. Each lot shall be generally divided into 100 m single lane sublots. When the last sublot is less than 50 m in length, it will be added to the previous sublot. Lot acceptance for surface smoothness shall be based on quality assurance (QA) measurements of IRI.

**8.02 Surface Smoothness Measurement**

**8.02.01 General**

For HMA surface, alteration of the surface course after paving and prior to the initial smoothness measurements, by micro-milling, diamond grinding/grooving, or any other method, shall not be permitted.

The Owner will measure all through lane pavement surfaces using an inertial profiler with the following exceptions:

a) Where the posted speed is 60 km/hour or less.

b) Where a HMA single lift is placed on an existing surface.

c) Within the first or last 10 m length of the new concrete pavement section where the new concrete pavement abuts against an existing asphalt or concrete pavement where the Contractor is not responsible for the adjoining surface.

d) Bridge decks and within 10 m of bridge deck expansion joints.

e) Detours and other temporary pavement that shall be removed or overlaid under this Contract.

f) Within 10 m of any access holes, water valves, or similar structures which are located within the lane.

g) Lanes less than 400 m in length.

h) Curves with a centerline radius of less than 300 m and pavement within the superelevation transition, i.e. slope changes, of such curves.

i) 100 m either side of a stop bar at signalized intersections.

j) 100 m either side of a stop bar at stop-controlled intersections for the lanes being measured for smoothness.

**8.02.02 Sublots to Be Measured**

The Contract Administrator will provide a draft sketch at the pre-start meeting showing the proposed details for the numbering and stations of each sublot. During preparation of the sublot sketch, if the last sublot is less than 50 m in length, then it will be added to the previous sublot in the lane. The Contract Administrator will finalize the sketch before the beginning of surface course paving. Prior to beginning the construction of the surface course, changes to the sketch or any areas may be proposed for consideration by the Contract Administrator.

**8.02.03 Inertial Profiler Measurements**

The Contract Administrator shall be notified, in writing, when the surface course is ready for QA acceptance testing. The Owner will perform QA acceptance testing not more than once per calendar year.

Prior to the QA acceptance testing, the Contractor shall clearly mark out the sublot number and the station for each sublot, the beginning and ending of any sublots that are shorter than or longer than 100 m as well as any additional sublot(s) that mark the beginning of an abrupt change in chainage, in a way that remains visible to the profiler operator until the final measurements are completed and accepted.

The QA inertial profiler will begin to carry out surface smoothness testing within 10 Business Days of the Contract Administrator receiving the written notification the surface course is ready for QA testing and the Contract Administrator is fully satisfied that the locations of the sublots, that are to be measured, have been properly marked out by the Contractor.

An inertial profiler will be required to do three runs of any particular pavement section. However, when the profiler operator deems that the results for one or more sublots within a particular run are invalid, due to technical difficulties or other reasons, then the profiler operator, after consultation with the Contract Administrator, will be allowed to repeat that run and the data file for the repeated run will be used to calculate the IRI for the affected sublot.

Within 7 Business Days after the surface smoothness measurements have been completed, the Contract Administrator will provide copies of the following on a portable flash drive or via e-mail:

a) All of the unfiltered data files that are generated by the inertial profiler for each profile run, including GPS data files;

b) A summary of the longitudinal reference lines and offsets that were used for each profile run;

c) A summary of all “lead-in” distances that the inertial profiler required, prior to the start of the first sublot being measured in every profile run;

d) Summaries of all IRI measurements in both wheel paths for each run of each sublot, as determined in accordance with LS-296, in Microsoft Excel spreadsheet file(s) including resultant pay factors.

After the measurements by the QA inertial profiler are analyzed, all areas to be repaired due to rejectable sublots shall be marked on the pavement surface at the direction of the Contract Administrator and prior to any repair work.

**8.02.04 Referee Testing**

For each measurement results taken by the QA inertial profiler, a single written request for referee testing may be submitted to the Contract Administrator no more than 5 Business Days after receipt of the smoothness results. Each request shall state the sublots that are to be re-measured.

The referee profiler shall consist of an inertial profiler that is chosen from a roster rotation list maintained by the Owner.

All sublots that are requested for referee testing will be re-measured three times using a referee profiler, within 15 Business Days of the Contract Administrator receiving the request for referee testing, unless ambient conditions do not permit reliable measurement. In the event the ambient conditions do not permit reliable measurement, the measurement will be conducted when ambient conditions allow. The disposition of all of the re-measured sublots shall be based on the referee measurements and the results shall be binding on both the Contractor and the Owner.

**8.02.05 Damage to Existing Pavement Surface after Preparation or Damage to Surface Course Prior to Smoothness Measurements**

The Contractor shall provide written documentation to the Contract Administrator within 1 Business Day of becoming aware of the damage to areas of:

a) Existing pavement surfaces underlying a sublot, which have been milled, ground and/or padded; or

b) Surface course within a sublot;

when such damage was due to circumstances beyond the Contractor’s control and occurred prior to measurement for surface smoothness. The Contractor shall not cover the affected area with hot mix until a decision is made by the Contract Administrator. The Contract Administrator will evaluate the Contractor’s submission and may exclude all or part of the affected area from the final calculation for the payment factor.

**8.03 Repairs and Redecisioning**

**8.03.01 General**

For any sublot with an IRI which is greater than 1.250 m/km, the sublot is rejected and shall be repaired according to the Repairs subsection of this Special Provision. Redecisioning shall be according to the Redecisioning clause of this Special Provision.

All repairs and the redecisioning of all sublots which are constructed in a given construction season shall be completed within 30 Days of the Contractor receiving written notice from the Contract Administrator that the last set of measurements had indicated repairs for those sublots. The Contractor shall inform the Contract Administrator, in writing, when the repaired sublots are ready for QA inertial profiler acceptance re-testing. The Contractor shall be responsible for the cost of QA inertial profiler acceptance re-testing.

**8.03.02 Repairs**

**8.03.03.01 General**

At least 5 Business Days prior to beginning any surface smoothness-related repairs, the Contractor shall submit a written notification to the Contract Administrator with the sublot and repair locations including the appropriate stations, length of each repair area, and the method(s) of repair that the Contractor intends to use for each repair area. The Contractor shall not start repairs unless the Contract Administrator has given written permission.

Surface smoothness-related repairs shall consist of one or more of the following corrective measures:

1. Diamond Grinding for HMA surface or diamond grinding/grooving for concrete surface;

b) A hot mix asphalt overlay, where permitted;

c) Remove and Replace; and/or

d) Other methods of repair, if approved by the Contract Administrator, in consultation with the Owner.

**8.03.03.02 Diamond Grinding or Grooving**

Diamond grinding, or grooving for concrete pavements, will not be allowed in any area of the surface course where that area will be reduced by more than 5 mm below the general profile of the surrounding pavement surface after the repair. For HMA surface course, a sublot shall be limited to no more than 3 separate diamond ground repair areas representing a total combined area not exceeding 20 percent of that sublot’s area. The slurry produced from diamond grinding/grooving shall be removed from the Working Area and managed as specified in the Contract Documents.

**8.03.03.03 Hot Mix Overlay / Remove and Replace**

Overlays on traffic lanes beneath structures may be allowed, if clearances between the pavement surface and the underside of the structure after overlay meet the established minimum requirements.

If a hot mix overlay or remove and replace repair is performed, it shall be re-tested for smoothness. The minimum width of all repairs by “hot mix overlay” or “remove and replace” shall be the width of the lane being repaired, i.e. between longitudinal joints, and including any pavement markings that may be present.

**8.03.03.04 Redecisioning**

When repairs are made to all or part(s) of any sublot, then the entire sublot will be re-tested by the QA inertial profiler at Contractor’s cost. Re-testing by QA inertial profiler will include at least 15 m on either side of the repaired area. If this requirement extends the testing onto an adjacent sublot, then the adjacent sublot will also be re-tested. After such repairs to the sublot, subsequent measurements will be used in the final calculations for the payment adjustment to the lot.

After a sublot is repaired due to high initial IRI’s, then the subsequent measurements of the sublot shall have an IRI less than or equal to 1.250 m/km.

**9.0 MEASUREMENT FOR PAYMENT - Not Used**

**10.0 BASIS OF PAYMENT**

Payment at the Contract price for the appropriate tender items for pavement construction shall include full compensation for all labour, Equipment, and Material to do the work.

**10.01 Corrections to the Surface Beneath Surface Course**

No additional payment will be made to the Contractor for the smoothness corrections described in subsection “Smoothness Correction of Pavement Surface(s) Beneath Surface Courses”.

**10.02 Payment Adjustment for IRI**

A sublot’s payment factor for smoothness shall be based on the initial QA IRI measurements, unless that sublot has been repaired or the initial QA IRI has been substituted or adjusted as a result of referee testing. Where a sublot has been repaired, the subsequent measurements taken after the repair will be used in the calculation for the payment adjustment to that sublot.

No sublot that has been repaired for any reason shall receive a payment factor greater than 1.0.

The individual payment factors for each sublot shall be determined by the Contract Administrator according to Table A.

The average payment factor for the entire lot shall be the average of the individual payment factors for all measured sublots of surface course within the lot, rounded to 3 decimal places according to LS 100.

The payment adjustment for the lot shall be:

Payment Adjustment = (PFS - 1.000) x Unit Price x Lot Quantity

Where,

PFS = the average payment factor for the lot.

Unit Price = the Contract price of the Performance Requirement - Surface Course item, or $25.00 for HMA pavement and $100.00 for concrete pavement when pavement construction is paid by lump sum item.

Lot Quantity = the theoretical area of surface course in the lot as determined by the Contract Administrator using the length of pavement on which the inertial profiler measurements were made and the design widths of the finished lane, excluding any paved shoulder.

**TABLE A - Sublot Payment Factor Based on IRI**

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| **Average IRI of both wheel paths from a set of 3 measurements for each sublot (m/km)** | **Sublot Payment Factor** |
| < 0.500 | 1.050 (Note 1) |
| 0.500 to 1.250 | 1.000 |
| > 1.250 | REJECTED (requires repair) |
| Notes:  1. The payment factor shall be equal to 1.000 for repaired sublots regardless of the reason for the repair. | |

**10.03 Repair Costs**

All repairs shall be made entirely at the Contractor’s expense. Where overlays are allowed, any other associated costs such as additional granular materials for shoulders, shall also be borne by the Contractor.

**10.04 Costs for Referee Testing**

If the Contractor requests referee testing and the average IRI for the sublots tested in that request is either higher or less than 10% lower than the average IRI determined from the original IRI measurements taken by the QA inertial profiler for those sublots, then the Contractor shall be charged the cost of the referee testing, otherwise, the Owner shall bear the cost.

The cost for referee testing shall be as specified in the Contract Documents.

WARRANT: Use only in consultation with Regional Geotechnical Section for contracts with 3, 5, or 7 years performance warranty.

CUSTODIAN: Seyed Tabib, EMO - Bituminous.