

**C Pavement Smoothness**

**C1 General**

Pavement smoothness will be evaluated on the final mainline pavement surface. Projects constructed with 3 or more lifts (1½" minimum) will be evaluated utilizing a Zero blanking band, unless otherwise specified in the special provisions. Projects constructed with 2 or less lifts will be evaluated utilizing a 5mm (0.2") blanking band. The following table shows pavement surfaces, which are excluded from profilograph testing, but subject to 2350.7B surface requirements.

**Table 2350-12  
Profilograph Testing Exclusions**

|   |
|---|
| Pavement Surfaces Excluded From Profilograph Testing  |
| Ramps, Loops, Climbing Lanes  |
| Side Streets, Side Connections  |
| Turn Lanes, Storage Lanes, Crossovers, Bypass Lanes   |
| Shoulders   |
| Acceleration, Deceleration Lanes  |
| Intersections constructed under traffic   |
| Sections less than 15.24m (50 ft) in length   |
| Projects less than 300 m (1000 ft) in length  |
| Mainline paving where the normally posted regulatory speed is less than or equal to 70 km/h (45 mph)                        |
| Single lift overlays over bituminous with a PSR < 2.8   |
| Single lift overlays over concrete.   |
| Horizontal Curves with a radius less than 950 ft. Horizontal Curves with a degree of curvature greater than or equal to 6°. |
| Vertical Curves – Absolute value of grade change is 2 % or more and curve length is 300 ft or less.                         |
| Vertical Curves – Absolute value of grade change is 3 % or more and curve length is 400 ft or less.                         |
| Vertical Curves – Absolute value of grade change is 4 % or more and curve length is 600 ft or less.                         |
| Vertical Curves – Absolute value of grade change is 8 % or more and curve length is 700 ft or less.                         |

**C1 A Smoothness Requirements**

Pavement smoothness requirements will be evaluated by Table 2350-13AZ, 2350-13B, or 2350-13C. The pavement smoothness table will be identified in the Special Provisions of the proposal.

**C2 Measurement**

Smoothness will be measured with a 7.62 m (25 ft) California type profilograph or a Lightweight Inertial Profiler (LWP), which produces a profilogram (profile trace of the surface tested). Either type of device must be certified according to the procedure on file in the Bituminous Office. One pass will be made in each lane, 2.74 m (9 ft) from centerline. Each lane will be tested and evaluated separately. The Engineer will determine the length in kilometers (miles) for each mainline traffic lane. The profilograph will be operated at a speed no greater than a normal walk, no greater than 6 km/hr (4 mph). Motive power may be provided manually or by the use of a propulsion unit approved by the Engineer. The LWP will be operated at the optimum speed as defined by the manufacturer.

**C3 Profilograph testing**

The Contractor will furnish a properly calibrated, documented, and certified 7.62 m (25 ft) California type profilograph or LWP. The profilograph or LWP shall be equipped with automatic data reduction capabilities unless otherwise authorized by the Engineer. Certification documentation shall be provided to the Engineer on the first day the profilograph or LWP is used on the project. User selected profilograph or LWP settings are on file in the Bituminous Office. The Contractor will furnish a competent operator, trained in the operation and evaluation of the 7.62 m (25 ft) California profilograph or LWP.

All objects and foreign material on the pavement surface will be removed by the Contractor prior to testing. The pavement surface will be divided into sections which represent continuous placement. A section will terminate 7.62m (25 ft) before a bridge approach panel, bridge surface, manhole or similar interruption. A day's work joint will be included in the trace with no special consideration. A section will be separated into segments of 0.1 km (0.1 mi) A segment will be in only one traffic lane.

A profilogram will be made for each segment of 15.24 m (50 ft) or more. The profilogram will include the 7.62 m (25 ft) at the ends of the section only when the Contractor is responsible for the adjoining surface.

End of run areas not included in the profilograph trace and any sections of pavement less than 15.24 m (50 ft) in length shall be checked longitudinally with a 3.028 m (10 ft) straight edge and the surface shall not deviate from a straight line by more than 3 mm in 3.028 m (1/8 inch in 10 ft).

The profile trace and index for each segment of pavement must be furnished to the Engineer within 48 hours after each days run. Identification of all bumps and dips, with signature of the Operator shall be included with the submitted trace.

The Contractor will submit a final evaluation generated from approved software, to the Engineer within five days after all mainline pavement placement. Software is available from the Mn/DOT Bituminous Office at [www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp](http://www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp). The evaluation submitted shall be in tabular form, with each 0.1 km (0.1 mile) segment occupying a row. Each row shall include the beginning and ending station for the segment, the length of the segment, the profile index for the segment, the profile index incentive/disincentive in dollars for the segment, and the deductions for bumps in dollars for the segment. Each continuous run will occupy a separate table and each table will have a header that includes the following: the project number, the roadway number or designation, the specified ride table, a lane designation, the mix type of the final lift, the PG binder of the final lift, the date of the profilograph run, and the beginning and ending station of the continuous run. Each table will have a summary at the bottom that includes the following: a subtotal for the profile index incentive/disincentive, a subtotal for the bump deductions, and a total for incentive/disincentive for both profile index and bumps.

The Contractor will be responsible for all traffic control associated with the smoothness testing.

Any portion of the project may be retested if the Engineer determines that the Contractor's test results are in question. If results are found to be inaccurate, the Contractor will be charged at a rate of \$155.34 per lane km (\$250 per lane mile) that is retested, with a minimum charge of \$500.00. If the results are found to be accurate, the Department will be paying the Contractor at a rate of \$155.34 per lane km (\$250 per lane mile) that is retested, with a minimum charge of \$500.00.

#### **C4 Profile Index**

The profilograph or LWP shall be equipped with automatic data reduction capabilities for determining the profile index (PI) unless otherwise authorized by the Engineer. If manual reduction is allowed, the profilograph trace will be evaluated by the Contractor for the profile index (PI) in accordance with California Method 526 on file with the Department Bituminous Engineer. The original trace shall be provided to the Engineer

A profile index shall be calculated for each segment. If a LWP is used the corresponding International Roughness Index (IRI) for each segment shall be submitted to the Bituminous Office. The index will be determined by summing the vertical deviations outside either a 5 mm (0.2 in) blanking band or outside a zero blanking band depending on the number of lifts in the construction. The units of this index are mm per km (inch per mile). When there is a segment of 76.2 m (250 ft) or less in length, the profilograph or LWP measurements for that segment shall be added to and included in the evaluation of the adjacent section to that segment.

Bumps and dips equal to or exceeding 10.2 mm in a 7.62 m (0.4 inch in a 25 ft) span shall be identified separately. When the profile trace shows a successive, uninterrupted bump, dip; or dip, bump combination (up to a maximum of 3 alternating trace deviations that relate to one bump or dip on the roadway), identify and evaluate these occurrences as one event.

#### **C5 Surface Correction**

All areas represented by deviations of 28 mm (1.1 in) or more, as measured by the 7.62 m (25 ft) profilograph, will be corrected by the Contractor.

The Contractor may elect to correct pavement segments having no more than two events or two individual bumps or dips with a vertical deviation of 10.2 to 25 mm (0.4 to 1.0 in) in a 7.62 m (25ft) span. Correction of segments with more than two events or two individual bumps or dips, as defined above, will be allowed only when approved by the Engineer. The Contractor will be assessed a penalty for dips or bumps of 10.2 to 25 mm (0.4 to 1.0 in) that are not corrected. Bumps and dips not corrected will also be included in the evaluation for the segment smoothness. Corrected dips or bumps will be considered satisfactory when the profilogram shows the dips or bumps are less than 10.2 mm in a 7.62 m (0.4 inch in a 25 ft) span.

Bump, dip, and smoothness correction work shall be for the entire traffic lane width. Pavement cross slope shall be maintained through corrective areas.

All corrective work shall be made by diamond grinding or approved equivalent, overlaying the area, by replacing the area or by inlaying. Corrective methods shall be subject to the approval of the Engineer. The Contractor shall notify the Engineer prior to commencement of the corrective action. If the surface is corrected by grinding, all ground areas shall be treated with an emulsified asphalt fog seal conforming to Specification 2355. If the surface is corrected by overlay, inlay or replacement, the surface correction shall begin and end with a transverse saw cut.

If the smoothness evaluation indicates that corrective work is necessary for more than 50% of a segment, surface correction will be limited to mill and inlay (40 mm (1 ½") min).

All corrective work shall be subject to the approval of the Engineer. After all required correction work is completed, a final profile index shall be determined. Corrective work and re-evaluation will be at the Contractor's expense.

## **C6 Payment**

The cost of certified smoothness testing and associated traffic control will be incidental to the cost of the Wear Course Mixture.

The Contractor may receive an incentive payment or be assessed a penalty based on the number of segments and the initial profile index. The total ride incentive shall not exceed 10% of the total mix price for pavement smoothness evaluated under Table 2350-13AZ, 5% of the total mix price for pavement smoothness evaluated under Table 2350-13B, or 5% of the total mix price for pavement smoothness evaluated under Table 2350-13C. The maximum allowable net incentive (total incentive minus disincentive) payment shall be calculated by multiplying the total tons paved by the mixture price by the appropriate incentive cap. Pay adjustments for incentives will only be based on the initial Profile Index before any corrective work has been performed. Pavement that contains corrective action for profile or bumps is not eligible for incentive pay. These payments or assessments will be based on the following schedules.

The Contractor will not receive a net incentive payment for ride if more than 25% of all density lots for the project fail to meet minimum density requirements.

For each traffic lane, a penalty will be assessed for each bump or dip of 10.2 to 25 mm (0.4 to 1.0 in) that is not corrected. Penalties, based on the table the profile index is evaluated under, are as follows:

|                  |       |
|------------------|-------|
| Table 2350-13AZ: | \$900 |
| Table 2350-13B:  | \$675 |
| Table 2350-13C:  | \$450 |

Bumps or dips resulting from a construction joint will be assessed a \$900 penalty, regardless of the table used for evaluation of pavement smoothness.

The Engineer may, at his discretion, assess a penalty in lieu of requiring the Contractor to take corrective action when the profile index for a segment indicates corrective action is necessary.

Penalties, based on the table the profile index is evaluated under, are as follows:

|                  |                                       |
|------------------|---------------------------------------|
| Table 2350-13AZ: | \$560 per 0.1 km (\$900 per 0.1 mile) |
| Table 2350-13B:  | \$420 per 0.1 km (\$675 per 0.1 mile) |
| Table 2350-13C:  | \$280 per 0.1 km (\$450 per 0.1 mile) |

**Table 2350-13 AZ**  
**Initial Profile Index <sup>(1)</sup> - - ZERO BLANKING BAND**

| mm per km<br>per 0.1 km segment | (Inches per mile)<br>(per 0.1 mile segment) | Dollars per<br>Segment<br>(Metric) | Dollars per<br>Segment<br>(English) |
|---------------------------------|---|------------------------------------|-------------------------------------|
| 0- 176.9                        | (0.0 - 11.2)                                | 190                                | 300                                 |
| 177.0 - 195.2                   | (11.3 - 12.4)                               | 130                                | 200                                 |
| 195.3 - 213.5                   | (12.5 - 13.6)                               | 70                                 | 100                                 |
| 213.6 - 272.8                   | (13.7 - 17.3)                               | 0                                  | 0                                   |
| 272.9 - 314.1                   | (17.4 - 19.9)                               | (70)*                              | (100)*                              |
| 315.7 - 353.6                   | (20.0 - 22.4)                               | (130)*                             | (200)*                              |
| 355.2 - 393.1                   | (22.5 - 24.9)                               | (190)*                             | (300)*                              |
| Over 394.7                      | (Over 25.0)                                 | Corrective<br>Action               | Corrective<br>Action                |

\* Since this is a pilot project provision, the disincentive values will not apply. However, corrective action will be required when profile index is over 394.7 mm/km (25.0 in/mile).

(1) If all segments in a project qualify for 100 percent payment with no grinding, the qualifying incentive payment will be increased by \$25 per metric segment and \$40 per English segment not to exceed the 10% cap. . This bonus is null and void if a disincentive could have been applied were it not for pilot provision requirements above.

**Table 2350-13 B**  
**Initial Profile Index for 5mm (0.2") blanking band**

| <b>mm per km<br/>per 0.1 km segment<br/>segment)</b> | <b>(Inches per mile)<br/>(per 0.1 mile</b> | <b>Dollars per<br/>Segment<br/>(Metric)</b> | <b>Dollars per<br/>Segment<br/>(English)</b> |
|--|--|---|--|
| 0 - 15.8   | (0.0 - 1.0)                                | 145   | 225  |
| 15.9 - 31.6  | (1.1 - 2.0)                                | 100   | 150  |
| 31.7 - 47.3  | (2.1 - 3.0)                                | 55  | 75   |
| 47.4 - 110.5   | (3.1 - 7.0)                                | 0   | 0  |
| 110.6 - 126.3  | (7.1 - 8.0)                                | ( 55)                                       | (75)   |
| 126.4 - 142.0  | (8.1 - 9.0)                                | (100)                                       | (150)  |
| 142.1 - 157.8  | (9.1- 10.0)                                | (145)                                       | (225)  |
| Over 157.8   | (Over 10.0)                                | Corrective<br>Action                        | Corrective<br>Action                         |

**Table 2350-13 C**  
**Initial Profile Index for 5mm (0.2") blanking band**

| <b>mm per km<br/>per 0.1 km segment<br/>segment)</b> | <b>(Inches per mile)<br/>(per 0.1 mile</b> | <b>Dollars per<br/>Segment<br/>(Metric)</b> | <b>Dollars per<br/>Segment<br/>(English)</b> |
|--|--|---|--|
| 0 - 31.6   | (0.0 - 2.0)                                | 95  | 150  |
| 31.7 - 47.4  | (2.1 - 3.0)                                | 65  | 100  |
| 47.5 - 79.0  | (3.1 - 5.0)                                | 35  | 50   |
| 79.1 - 158.0   | (5.1 - 10.0)                               | 0   | 0  |
| 158.1 - 189.6  | (10.1 - 12.0)                              | (35)  | (50)   |
| 189.7 - 221.2  | (12.1 - 14.0)                              | (65)  | (100)  |
| 221.3 - 252.8  | (14.1-16.0)                                | (95)  | (150)  |
| Over (252.8)   | (Over 16.0)                                | Corrective<br>Action                        | Corrective<br>Action                         |