

SECTION 602 -- PORTLAND CEMENT CONCRETE PAVEMENT SMOOTHNESS

602.01 -- General

1. This specification establishes a standard for portland cement concrete pavement smoothness and defines defective pavement smoothness. It is the intent that the portland cement concrete pavement placement operation produce a finished driving lane surface with a profile index no greater than 155 mm/km.
2. Pavement smoothness shall not be evaluated on pavement projects less than 0.16 km in length.

602.02 -- Equipment

1. The Contractor shall furnish a California profilograph that has been approved by the NDR Materials and Tests Division. The equipment furnished shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no 2 wheels cross any bump at the same time. The pavement profile shall be recorded from the vertical movement of a sensing wheel attached to the frame at its mid-point and whose movement is in reference to the mean elevation of the 12 contact points established by the support wheels. The profilogram shall be recorded with a scale of 1 mm equals 1 mm vertically and 1 mm equals 300 mm longitudinally.
2. All profilographs must be equipped with computers that will automatically record, analyze, and report the profile test data.

602.03 -- Profilograph Calibration

1. All profilographs shall be calibrated annually on a test section established by the Department. The Contractor's calibration profile index shall not vary more than 15 mm/km from a standard profile index produced by a Department profilograph.
2. The Contractor shall furnish evidence that the profilograph was calibrated and the profile data was gathered by a certified operator. An operator may be certified by presenting certification from another state highway agency or by successfully completing a certification workshop conducted by the Department.
3. Longitudinal calibration will consist of propelling the profilograph over a pre-measured test distance and determining the scale factor by dividing the pre-measured test distance by the length of the paper in millimeters. This factor shall be 300 (1 mm equals 300 mm). If not, the machine shall be adjusted until the scale factor is 300 ± 0.2 percent.
4. Vertical calibration will consist of sliding a pre-measured calibration block, measured to the nearest 0.25 mm, under the sensing wheel while the profilograph is stationary. The measurement of the vertical trace line from the base line to the peak and return shall be the same as the calibration block. The trace line must return to the base line.

Tolerances will be:

1 mm for the 25.0 mm calibration block
2 mm for the 50.0 mm calibration block

5. The automatic profile trace reduction capabilities shall be checked by comparing the machine's results with the results obtained with the NDR computerized profilograph. The results and the profilogram shall be submitted to the Engineer. The results of the comparison may not differ by more than 15 mm/km.

602.04 -- Profilograph Test Procedures

1. a. Testing shall be done by a certified operator in the presence of the Engineer. If the Engineer is notified of a proposed test by the Contractor and elects not to be present, then the Contractor may, with the Engineer's approval, proceed unaccompanied.

b. The operator and the Engineer shall sign and date the traces immediately after tests are completed.

2. All testing will be done by the Contractor. The California type profilograph shall produce a profilogram (profile trace) of the surface tested.

3. a. The Contractor will make every reasonable effort to provide initial test results to the Engineer within 72 hours after concrete placement.

b. Additional testing should be completed and provided to the Engineer as soon as possible, but not later than 7 calendar days after completion of the mainline pavement.

c. Surface profile correction testing shall be completed and provided to the Engineer within 72 hours after the corrective work is complete.

4. a. Testing will be done in the right-hand wheel path of all driving lanes, including climbing and fly-by lanes.

b. In urban areas where inlet blockouts are in the right-hand wheel path, testing will be done in the center of the lane.

5. All objects and foreign material on the pavement surface shall be removed by the Contractor before testing.

6. The profilograph shall be propelled at walking speed along the specified wheel path of each travel lane. Propulsion may be provided by personnel pushing manually or by a suitable propulsion unit.

7. A location indicator for lateral placement is mandatory. More than one person may be required to hold the back end of the profilograph exactly on the required path on horizontal curves.

8. Propelling speed shall be decreased if significant spikes are being produced.
9. Before testing, the Contractor shall lower the sensing wheel to the pavement surface and propel the profilograph forward to the beginning location of the test section to stabilize the measurement system. The Contractor shall also check and adjust the sensing wheel tire pressure several times daily.
10.
 - a. Stationing shall be noted on the profilogram at least every 50 m.
 - b. Station referencing is used to accurately locate vertical deviations greater than 10 mm.
 - c. All station references used on the profilograms and report forms shall be the actual project stationing.
 - d. The Contractor shall mark pavement that is to be ground to meet smoothness criteria.
11. Both ends of each profilogram shall be labeled with the:
 - a. Project number.
 - b. Test date.
 - c. Traffic direction.
 - d. Traffic lane.
 - e. Test direction.
 - f. Test path.
 - g. Test number.
 - h. Operator's name.
 - i. Stationing.
 - j. Lane designation.
 - k. Position on the pavement.
 - l. Direction the pavement was placed.
12. A report form furnished by the Engineer shall be completed and attached to the profilogram.
13. When the profilograph is being operated, all wheels shall be on the new pavement for which the Contractor is responsible.

14. The profilograms shall be signed by the Engineer immediately after completion of the tests. If the Engineer was not present, then the absence shall be noted on the profilogram.

15. The Engineer may also test the surface for comparison and assurance purposes. If these tests indicate the Contractor-furnished profilograms are not accurate, the Engineer may:

a. Require the Contractor to recalibrate the profilograph equipment and reaccomplish the tests.

b. (1) Choose to perform the test for a portion or for the entire length of the project.

(2) The Contractor will be charged \$300.00 per lane-kilometer for all testing done by the Engineer because of verified inaccuracies in the Contractor-furnished profilograms.

(3) Furnishing inaccurate test results may result in disapproval of the Contractor's operator or equipment.

16. Unless otherwise specified in the special provisions, the following areas of pavement will not be evaluated for smoothness:

a. Pavement on horizontal curves having a centerline radius of curvature of less than 300 m and pavement within the superelevation transition of such curves.

b. Pavement within 15 m of a transverse joint that separates the pavement from an approach slab to a bridge deck or an existing pavement not constructed under the contract.

c. Pavement for exit ramp termini, truck weigh stations, and ramps and connectors with steep grades and high rates of superelevation.

d. Isolated sections less than 100 m long (e.g., between two bridges).

e. Pavement within 15 m of railroad crossings and associated transitions.

f. Additional exceptions shown on the summary sheet in the plans.

17. Pavement sections which are excluded from this specification will be measured for bumps with either a profilograph or a 3 m straightedge. If a 3 m straightedge is used, the variation of the surface shall not exceed 3 mm.

18. The pavement surface will be divided into lane width increments which end at a bridge, railroad crossing, or other designated termini. The lane increments will be divided into 200 m test sections in the direction tested with the remaining short pieces also considered as test sections.

19. If a "short" section is less than 100 m long, it will be added to the preceding section and a profile index will be calculated for the adjusted length. Sections which are 100 m or longer will be considered full sections.

602.05 -- Evaluation

1. A profile index will be calculated by the Contractor and furnished within 2 NDR work days to the Engineer along with the profile trace for each section. The index is calculated by summing the vertical deviations outside a 5.00 mm blanking band. The units of this measurement are millimeters per kilometer.

2. Bumps will be separately identified. These appear as high points on the profile trace and correspond to high points or bumps on the pavement surface. They are identified by locating vertical deviations exceeding 7.6 mm in height for a 7.62 m span as shown on the profile trace.

3. When surface correction is required, the original profilogram results will be considered a preliminary profile index.

602.06 -- Pavement Surface Correction

1. All corrective work shall be done with the approval and in the presence of the Engineer.

2. When the profile index of a section is 230 mm/km or less, no corrective action will be allowed, except bump removal, to increase the pay factor.

3. When the profile index of a section exceeds 230 mm/km, the Contractor shall take corrective action to reduce the profile index to 230 mm/km or less. Any corrective work shall be at no additional cost to the Department.

4. a. All points/bumps greater than 7.6 mm above the uniform pavement surface elevation shall be corrected/ground.

b. Corrective work may be required for any bump, combination of bumps, or other roughness that, in the opinion of the Engineer, produces an objectionable ride.

c. Corrected bumps will be considered satisfactory when measurement with the profilograph shows that the bumps are 7.6 mm or less in a 7.62 m span.

5. a. When the profile of a pavement placed under this contract is corrected by removing and replacing, the replacement material and construction shall be furnished by the Contractor, at no additional cost to the Department, and shall meet the original specifications for the material removed.

b. Removal and replacement shall be for the full lane-width for a distance determined by the Engineer.

c. The replacement material shall be retested for smoothness.

602.07 -- Traffic Control

The Contractor shall, at no additional cost to the Department, furnish all traffic control requirements. This includes devices like barricades.

602.08 -- Profile Index -- Accepted Quantities

1. The unit price of the accepted quantity of portland cement concrete pavement for driving lanes will be adjusted according to the following schedule in Table 602.01 as measured by the profilograph.

Table 602.01

Payment Adjustment Schedule	
<u>Profile Index</u> <u>Millimeters Per Lane Kilometer</u>	<u>Percent of</u> <u>Contract Prices</u>
0 mm to 30 mm	105
More than 30 mm to 45 mm	104
More than 45 mm to 60 mm	103
More than 60 mm to 75 mm	101
More than 75 mm to 155 mm	100
More than 155 mm to 170 mm	98
More than 170 mm to 185 mm	96
More than 185 mm to 200 mm	94
More than 200 mm to 215 mm	92
More than 215 mm to 230 mm	90
More than 230 mm	Corrective work required

2. Subject to the limitations in Paragraphs 3. and 4. of this Subsection, the profile index of a section after bump removal will be used to determine the percent of pay for the section.

3. When the initial profile index is more than 155 mm/km, then, except for total removal and replacement, the maximum percent of pay will be limited to 100 percent.

4. The work of smoothness testing shall be paid for at the lump sum contract unit price. This price shall be full compensation for all smoothness testing as set forth in this specification.

602.09 -- Profilograph Pay Factor Calculation

1. The pay factor for concrete pavement smoothness will be determined according to the following formula:

Pay Factor Formula

$$PF = \frac{A(1.05)+B(1.04)+C(1.03)+D(1.01)+E(1.00)+F(0.98)+G(0.96)+H(0.94)+I(0.92)+J(0.90)}{A + B + C + D + E + F + G + H + I + J}$$

Where: A = length of pavement with a profile index of 0 to 30

B = length of pavement with a profile index greater than 30 to 45

C = length of pavement with a profile index greater than 45 to 60

D = length of pavement with a profile index greater than 60 to 75

E = length of pavement with a profile index greater than 75 to 155

F = length of pavement with a profile index greater than 155 to 170

G = length of pavement with a profile index greater than 170 to 185

H = length of pavement with a profile index greater than 185 to 200

I = length of pavement with a profile index greater than 200 to 215

J = length of pavement with a profile index greater than 215 to 230