

**OKLAHOMA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
FOR
PAVEMENT AND BRIDGE DECK SMOOTHNESS
(ENGLISH AND METRIC)**

These Special Provisions amend and where in conflict, supersede applicable sections of the 1999 Standard Specifications for Highway Construction, English and Metric. Units of measurement are provided in the subsections in both English and Metric equivalents. The units for this project will be those specified in the project plans.

Except as noted herein, these Special Provisions apply to all types of Portland cement and asphalt concrete pavements as well as bridge decks constructed as part of this contract or as specified on the Plans.

430.01. DESCRIPTION.

This section establishes procedures for determining acceptability and pay adjustments as they relate to smoothness requirements of pavements and bridge decks. The equipment and testing applicable to this Section shall be provided and/or operated by the party or parties specified in Special Provision 431-3QA.

430.03. EQUIPMENT.

Smoothness measurement equipment to be used for control and for acceptance testing shall include either The California Profilograph or The Lightweight Profilometer as described below. Such equipment shall be certified by the Department.

(a) Profilograph. A California type profilograph produces a smoothness profilogram (or profile trace) of the surface tested. The equipment used shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no two wheels cross the same bump simultaneously. The profile is recorded from the vertical movement of a sensing wheel attached to the frame at the midpoint and is in reference to the mean elevation of the twelve points of contact with the road surface established by the support wheels.

The strip chart recorder shall be mounted on a lightweight frame 25 feet (7.62 meters) long. The relative smoothness/roughness of the pavement or bridge deck shall be measured by recording the vertical movement of a 6 inch (152 millimeter) or a larger diameter sensing wheel attached to the midpoint of the frame.

The recorded graphical traces of the profile (termed the "profilogram") shall be on a scale of 1 inch (1 millimeter) equals 1 inch (1 millimeter) for the vertical motion of the sensing wheel. The profilogram shall be driven by the chart drive on a scale of 1 inch (1 centimeter) of chart paper equal to 25 feet (3 meters) of longitudinal movement of the profilograph.

(b) Light weight Profilometer. The profilometer equipment shall be mounted on a lightweight, motorized vehicle such as an All-Terrain Vehicle (ATV), Golf Cart, or other approved vehicle. The vehicle profilometer equipment, and operator shall be capable of running on "green" concrete without causing damage. The profilometer equipment shall include an onboard, precision accelerometer which measures movement of the light weight and a non-contact vertical distance sensor mounted on the vehicle. The vertical distance sensor may be either infrared or laser type. The profilometer shall be capable of making all of the measurements and providing the

information required in 430.04(b) of this special provision. Additionally, the profilometer shall measure the road profile in accordance with ASTM E950-98, Class I.

- (c) Calibration. The profilograph or profilometer shall be calibrated within the following limits. Horizontal measurements shall be within ± 5 feet (meters) per 1,000 feet (meters) of distance tested. Vertical measurements shall be the same as those of the calibration blocks measured. A profilograph or profilometer Calibration Report shall be submitted to the Engineer each time the calibration is performed. An appropriate form will be provided to the Contractor by the Engineer. The calibration shall be performed no more than one week prior to collection of smoothness data and repeated at the Engineer's direction at any time during the Project.
- (d) Profilograph or profilometer Operator. When specified in Special Provision 431-3QA the Contractor shall provide a profilograph or profilometer operator, certified by the Oklahoma Highway Construction Materials Technical Certification Board to perform all profilograph or profilometer measurements as well as interpreting and analyzing produced profilograms.

430.04. CONSTRUCTION.

- (a) Surface Testing. The Contractor shall provide traffic control as necessary for all smoothness measurements regardless of who provides and/or operates the equipment. When specified in Special Provision 431-3QA the Contractor shall use an acceptable and approved profilograph or profilometer for measurement of pavement smoothness. The surface will be tested as soon as possible after completion of the work. For overlay projects when milling is not required, the surface will be tested immediately before construction and as soon as possible after completion of the work in order to determine the percent reduction in the profile index. Profilometer readings or profilograph traces are to be collected from 25 feet prior to the beginning point of a project, including any exception areas, and run continuously through all bridges and changes in the pavement types to a point 25 feet beyond the ending point of a project, including any exception areas.

Testing shall include all mainline paving and bridge decks. Smoothness deviations occurring at construction and expansion joints will be considered in calculations of profile index and in identification of bumps.

All objects and foreign material on the surface shall be removed by the Contractor prior to testing. Protective covers, if used, shall be removed prior to testing and will be properly replaced by the Contractor after testing. Testing for smoothness shall produce a final trace; a second trace shall be made on segments on which allowable surface corrections have been made.

The profilograph shall be propelled at a speed not to exceed 3 miles (5 kilometers) per hour. Data shall be gathered at lower speeds if the pavement or bridge deck is rough or profilograms are not being produced clearly.

The profilometer shall be operated at a constant speed as recommended by the manufacturer.

The sequence of position of the pavement or bridge deck to be tested will be one pass per driving lane in the wheel path farthest from the edge of a pavement or bridge deck.

Additional profiles will be taken only to define the limits of an out-of-tolerance surface variation. When the Contractor is required by Special Provision 431-3QA to operate the profilograph or profilometer he shall furnish the profilogram evaluations to the Department. The evaluations shall include graphical traces of the profiles and the disks from which they were derived. The testing and evaluation will be done by a trained and certified operator and the evaluation will be so certified. The Department reserves the right to verify the testing and/or evaluation. In case of differences the Department's results shall be considered final. If the Contractor's results are found to be significantly in error, the Department may assess the cost of the verification efforts.

- (b) Evaluation.

1. *Profile Index.* Unless otherwise specified in Special Provision 431-3QA, a profile index shall be calculated from the profilogram for a pavement or bridge deck on 528 feet(161 meters) extents or entire lengths of bridges(including approach slabs) whichever is less. The index shall be calculated using a computerized profilogram reduction system. It is understood that stations reflected by automated profilogram interpretation systems are approximate and a further survey in the field may be required to establish bump locations. The index is calculated by summing the vertical deviations outside a 0.2 inch (5 millimeter) blanking band as indicated on the profile trace. The units of this measure (inches or millimeters) will be converted into inches per mile or millimeters per kilometer. An extent is defined as the amount of pavement or bridge deck in a 528 feet (161 meters) or the entire bridge deck plus both approaches in length, whichever is less. When the quantity represented is less than a full extent in length, it will be combined with an adjacent extent or treated as a separate extent, at the option of the Contractor.
2. *Bumps.* Bumps will appear as high points on the profile trace and correspond to high points on the pavement or bridge deck surfaces. Unacceptable bumps are defined as those with vertical deviations in excess of 0.60 inch (15 millimeters) (without using a blanking band) in a 25 foot (7.62 meter) span.
3. *Exceptions.* The following will be excluded form the smoothness requirements:
 - (a) Shoulders
 - (b) Ramps
 - (c) Turn Lanes
 - (d) Acceleration, deceleration and climbing lanes less than 528 feet full width.
 - (e) Pavement with horizontal centerline curves with radii of less than 1000 feet and the super elevation transitions of such curves.
 - (f) In overlays only, areas in roadway within a 10 foot radius of existing inlets and utility covers. (This exception does not apply to full depth pavements.)
 - (g) Short isolated pavement areas, which by normal industry practice would require handwork. Examples include driveway blockouts, phased intersection work with variable cross slope, etc.

For the above exceptions, the profile index and adjustments calculations corrections specified in this Special Provision, will not apply. However, the requirements for mandatory correction of bumps as defined in this Special Provision and tolerances defined in subsection 401.04 of the Standard Specification for Highway construction will remain in effect.
4. *Special Evaluation Requirements.* Bridge approach slabs will be evaluated in accordance with bridge deck smoothness requirements. New pavements and overlays within 50 feet(15.25 meters) of bridges or their approach slabs, 50 feet(15.25 meters) of beginning and ending stations of the Project, or 50 feet(15.25 meters) of changes from portland cement concrete to asphalt concrete or vice versa will be excluded from profile index calculation. However, the requirements for mandatory correction of bumps as defined in this Special Provision and tolerances defined in subsection 401.04 of the Standard Specification for Highway construction will remain in effect. Such corrections (including grinding) will not affect pay factors of individual extents or a possible bonus for overall smoothness.

- (c) Surface Correction. Unless otherwise permitted by the Engineer, in writing, all new pavements, overlaid pavements (with or without prior cold milling) and bridge deck surfaces having profile indices in excess of the acceptable limits in Tables I, II and III, or having individual bumps with deviations in excess of 0.60 inch (15 millimeter) in a 25 foot (7.62 meter) span shall be corrected by the Contractor at no additional cost to the Department. Such corrective actions shall NOT include any grinding of metal expansion joints, themselves, but may include grinding of concrete in the vicinity of the joints. **Except as noted below** (Subsection 430.06), any corrective action shall be for the purpose of satisfying these "must correct" requirements and will not improve the pay factor. When a bump or unacceptable rough section of pavement or bridge is permitted to be excluded from the correction by the Engineer it will be considered as a "ground area" for purposes of incentive determinations with the as built profile used for payment purposes. All corrective action, including the identification and correction of bumps, shall be in accordance with the requirements of the Standard Specifications and shall be subject to the approval of the Engineer. The surfaces of ground asphalt pavements shall be fog sealed in accordance with the plan note. The surfaces of corrected areas shall be retextured to be similar to that of the adjacent sections of pavement or bridge deck and shall exhibit good workmanship and be neat in appearance. Cores for thickness determinations and measurement of cover of reinforcement steel will be taken subsequently to all corrective work.

430.06. BASIS OF PAYMENT.

Except as noted below, pay factors for smoothness of pavements and bridge decks will be based on the INITIAL profile indices determined prior to any corrective actions. The exceptions to this are as follows:

- A. PAVEMENTS - Pay factors for smoothness of those sections removed and replaced or overlaid in a manner approved by the Engineer will be based on the profile indices determined after to these corrective actions but prior to any grinding. (Pay for pavements cannot be increased by grinding.)
- B. BRIDGES - Pay factors for smoothness of those sections removed and replaced, overlaid OR GROUND in a manner approved by the Engineer will be based on the profile indices determined AFTER those corrective actions. (Subject to the limitation in "C" below.)
- C. BOTH PAVEMENTS AND BRIDGES - Pay for extents that are ground on the surface course, for any reason will be limited to a maximum of full pay. (This limitation even applies to pavements and bridge extents whose profile indices would otherwise justify incentive pay.)

Smoothness pay adjustment will be determined for each extent in accordance with the following formula:

$$PA = (Sm - 1) \times CUP \times Qe$$

Where:

- PA = Smoothness Pay Adjustments (\$)
- CUP = Contract Unit Price (\$/TON (\$/Metric Ton), \$/ Yd² (\$ / M²), or \$ / Yd³ (\$ / M³) for each pay item
- Sm = Pay Factor from equations in Tables I through III.
- Qe = Quantity of Contract Pay Item in an Extent (TON (Metric Ton), Yd² (M²), or Yd³ (M³))

The quantity of P.C. concrete pavement in the extent will be the square yards (square meters) and/or the cubic yards (cubic meters) of new concrete in the driving lane. Cubic yards (cubic meters) will be determined from the theoretical volume of concrete which is in the driving lane.

The quantity of asphalt pavement in the extent will be the tonnage or square yards (square meters) in the full depth or overlay of new asphalt concrete in the driving lane. Tonnage will be determined from unit weights from the project job mix formula and typical sections as shown on the Plans.

The quantity of bridge deck in the extent will be the theoretical volume in cubic yards (cubic meters) or square yards (square meters) of new concrete which is in the driving lane.

Driving lane is defined as a thoroughfare with a width of at least 12 feet (3.66 meters) or as noted on the plan typical sections.

Items excluded from the Smoothness Pay Adjustment are: Base materials of any type as covered in Section 300 of the Standard Specifications; Patching pay items and quantities; Bond Breakers, and Asphalt Leveling Courses. Asphalt Leveling Courses will be included for a Smoothness Pay Adjustment for asphalt surfacing when the leveling course is specified in the plan typical for the entire station extents of the plan typical section.

Determination of the resulting smoothness pay factors will be in accordance with the tables shown below:

TABLE I (ENGLISH) ¹
ROADWAY (TONS OR Yd² OF PAVEMENT)
For Newly Constructed or Milled and Overlaid Surfaces

Profile Index (in/mi)	Pay Factor Equation¹
Class I ²	
3.0 or less	$PF = 1.03$
3.1 through 12	$PF = 1.059 - 0.0097 PI$
12.1 through 16.0	$PF = 1.480 - 0.0445 PI$
More than 16.0	Unacceptable
Class II ²	
5.0 or less	$PF = 1.03$
5.1 through 12.0	$PF = 1.083 - 0.0106 PI$
12.1 through 18.0	$PF = 1.320 - 0.0302 PI$
More than 18.0	Unacceptable
Class III ²	
7.0 or less	$PF = 1.03$
7.1 through 14.0	$PF = 1.090 - 0.00857 PI$
14.01 through 20.0	$PF = 1.390 - 0.02985 PI$
More than 20.0	Unacceptable

TABLE I (METRIC)
ROADWAY (METRIC TONS OR M² OF PAVEMENT)
For Newly Constructed or Milled and Overlaid Surfaces

Profile Index (mm/km)	Pay Factor Equation ¹
Class I ²	
47 or less	$PF = 1.03$
47.1 through 190.0	$PF = 1.059 - 0.000615PI$
190.1 through 253.0	$PF = 1.478 - 0.00282PI$
More than 253.0	Unacceptable
Class II ²	
78.0 or less	$PF = 1.03$
78.1 through 190.0	$PF = 1.082 - 0.000672PI$
190.1 through 285.0	$PF = 1.317 - 0.001913PI$
More than 285.0	Unacceptable
Class III ²	
110 or less	$PF = 1.03$
110.1 through 222.0	$PF = 1.090 - 0.000543PI$
222.1 through 317.0	$PF = 1.389 - 0.001891PI$
More than 317.0	Unacceptable

¹ Where PF = Pay, Factor and PI = Profile Index (%).

² The road classification, when applicable, is specified in Special Provision 431-3QA, a part of this contract. THE CLASSIFICATION SPECIFIED IS FINAL AND WILL BE USED AS A BASIS FOR PAYMENT.

TABLE II
ROADWAY (TONS(METRIC TONS) OR Yd² (M²) OF PAVEMENT)
For Overlays of When Milling is Not Required
Total Nominal Thickness > 1.5 inches(40 mm)

Reduction in Profile Index (%)	Pay Factor Equation ¹
90 or more	$PF = 1.03$
89.9 through 60	$PF = 0.800 + 0.00255 PI$
59.9 through 50.0	$PF = 0.01588 PI$
Less then 50.0	Unacceptable

TABLE II
ROADWAY (TONS(METRIC TONS) OR Yd² (M²) OF PAVEMENT)
For Overlays of When Milling is Not Required
Total Nominal Thickness ≤ 1.5 inches(40 mm)

Reduction in Profile Index (%)	Pay Factor Equation ¹
85 or more	$PF = 1.03$
84.9 through 55.0	$PF = 0.813 + 0.00255 PI$
54.9 through 45.0	$PF = 0.0793 + 0.01588 PI$
Less then 45.0	Unacceptable

¹ Where $PA = \text{Pay } PI = \text{Reduction in Profile Index } (\%)$

NOTE: In the event that the pay factor from TABLE II results in less than the pay factor that would be established by using TABLE I, the pay factor will be derived from TABLE I.

TABLE III
(ENGLISH)
BRIDGE DECK (Yd³ OF CONCRETE)

CLASS I ²	
Profile Index (in/mi)	Pay Factor Equations ¹
12 or less	$PF = 1.05$
12.1 through 35.0	$PF = 1.116 - 0.00563PI$
35.1 through 50.0	$PF = 1.849 - 0.0263PI$
More than 50.0	Unacceptable
CLASS II ²	
15 or less	$PF = 1.05$
15.1 through 35.0	$PF = 1.133 - 0.00563PI$
35.1 through 53.0	$PF = 1.928 - 0.0263PI$
More than 53.0	Unacceptable

(METRIC)
BRIDGE DECK (M³ OF CONCRETE)

CLASS I ²	
Profile Index (in/mi)	Pay Factor Equations ¹
238 or less	$PF = 1.05$
238.1 through 601.0	$PF = 1.116 - 0.000353PI$
601.1 through 836.0	$PF = 1.853 - 0.00167PI$
More than 836.0	Unacceptable
CLASS II ²	
285 or less	$PF = 1.05$
285.1 through 601.0	$PF = 1.133 - 0.000357PI$
601.1 through 884.0	$PF = 1.932 - 0.00167PI$
More than 884.0	Unacceptable

¹ Where PF = Pay Factor and PI = Profile Index

² The bridge deck classification, when applicable, is specified in Special Provision 431-3QA, a part of this contract. THE CLASSIFICATION SPECIFIED IS FINAL AND WILL BE USED AS A BASIS FOR PAYMENT.

Incentive for Consistently Smooth Pavement and Bridge Decks. In addition to the pay adjustments on pavement and bridge deck extents, a 2% bonus will be paid for mainline pavements and bridge decks that are consistently smooth throughout the subproject length. (A subproject is defined as all of the mainline PC concrete pavement, all of the mainline asphalt concrete pavement, or all entire bridge decks, including approach slabs in the project) Except for pavement tie-in's covered in Subsection 430.04(B)4, to be eligible for the bonus a subproject must have no extents with pay less than 1.00 and corrective actions limited to the following:

- A. *Portland Cement Concrete Pavement* - Total slab replacement.
- B. *Asphalt Concrete Pavement* - Total or upper layer replacement.
- C. *Bridges* - Total deck and/or approach slab replacement.

Subprojects with defects(as defined in Subsection 430.04(c)) which the Engineer permits to remain uncorrected will not be eligible for the bonus.

The quantity to which the 2.0% bonus will apply will be total of those quantities computed for the individual extents. This incentive provision applies to all constructed bridges, roadways, overlays of milled surfaces, and overlays when milling is not required(EVERYTHING IN TABLES I, II AND III ABOVE).