SECTION 610
PAVEMENT SMOOTHNESS

610.1 Description. This work shall consist of measuring the smoothness of the final pavement surface. Smoothness shall be measured using the International Roughness Index (IRI). The following pavement types shall comply with this specification:

a) Multi-lift asphalt construction contained in Secs 401 and 403.

b) Concrete pavement construction contained in Secs 502 and 506.

c) Combination of surface planning, such as diamond grinding or milling, and single lift asphalt construction contained in Secs 401 and 403.

d) Single lift asphalt construction contained in Secs 401 and 403.

610.2 Material Requirements.

610.2.1 Inertial Profiler. IRI shall be computed from profile data collected with an inertial profiler (IP) that meets the requirements of AASHTO M 328

610.2.2 ProVAL Software. The ProVAL software program shall be used to compute IRI smoothness and locate areas of localized roughness (ALR) in accordance with MoDOT TM-59.

610.2.3 Straightedge. A rolling 10-foot straightedge shall be used for checking longitudinal elevation changes. A 4-foot straightedge shall be used for checking transverse elevation changes.

610.3 Certification. All inertial profilers used to collect data on MoDOT projects shall be annually certified at the MoDOT certification site in accordance with TM-59. The operator of the IP shall be certified through the MoDOT technician certification program.

610.4 Construction Requirements.

610.4.1 Smoothness Increments. Length of pavement shall be defined in the following increments for the purpose of smoothness acceptance:

a) Section – A section is a day's paving and shall begin and terminate at the construction joints. Interruptions designated by the engineer which cause placement to cease and begin at a new location will considered as a separate section for that day's operation if the separate section is greater than 250 feet.

b) Segment – Sections shall be divided into segments of 0.1 mile lengths with the exception of the last segment. If the last segment is greater than 250 feet and less than 0.1 mile, then the segment shall be measured for smoothness as an independent segment. If the last segment is 250 feet or less, the profile for that segment shall be included in the evaluation for the previous segment. The combined segment IRI shall be weighted for the length.

610.4.2 Profiling Areas.

610.4.2.1 Profiling will be applicable to the surface of all the following:

a) Mainline paving

b) Auxiliary lanes, turning lanes and ramps for projects or combination of projects, consisting of more than 0.5 mile of total profilable pavement.

610.4.2.2 Profiling will not be required for the following exceptions:

(a) Bridge decks, bridge approach slabs and concrete approach pavements.

(b) Pavement on horizontal curves with centerline radius of curve less than 1000 feet and pavement within the superelevation transition of such curves.

(c) Pavement on vertical curves having a "K" value less than 90 and a length less than 500 feet.

(d) Pavement width transitions.

(e) Fifty feet in direction of travel on each side of utility appurtenances such as manholes and valve boxes.

(f) Fifty feet in direction of travel on each side of intersecting routes with special grade transition.

(g) Shoulders.

(h) Interruptions designated by the engineer which provide independently placed sections shorter than 50 feet.

(i) The last 15 feet of any section where the prime contractor is not responsible for the adjoining surface.

(j) Any lane which abuts an existing lane not constructed under the same contract.

610.4.2.3 In addition to the exceptions in Sec 610.4.2.2, profiling may be waived by the engineer if staging of the overall project; such as multiple entrance lane gaps, lane staging, etc.; affects the normal paving operation, or if multiple profile exceptions continuously exist on a large portion of the same roadway. Upon waiver, exempted areas shall be checked with a 10-foot straightedge.

610.4.3 Longitudinal Straightedging. Any pavement surface not measured with an inertial profiler shall be measured with a 10-foot straightedge. The straightedge path in the longitudinal direction for driving lanes will be located three feet from the outside edge and for shoulders will be located in the center. Additional paths with suspect roughness may be selected at the engineer's discretion. Shoulders that are paved integrally with an adjacent driving lane will not require straightedging. The engineer also has discretion to use a straightedge for spot checking pavement that had been measured with an inertial profiler. Any variations in the longitudinal direction exceeding 1/4 inch in 10 feet on shoulders and 1/8 inch in 10 feet on all other pavements shall be marked for correction in a manner approved by the engineer.

610.4.4 Transverse Straightedging. The engineer shall randomly check driving lanes, regardless of the smoothness measurement method used, for variations in the transverse direction with a 4-foot straightedge. Any variations in the transverse direction more than 1/4 inch shall be marked for correction in a manner approved by the engineer.

610.4.5 Full Depth Pavement and Multi-lift Overlays. These construction procedures apply to pavement treatments described in Sec 610.1 (a) and (b).

610.4.5.1 Quality Control Testing. The contractor shall perform quality control (QC) testing on all eligible profiling areas and provide electronic files for smoothness data in .PFF file format to the engineer in accordance with the testing and reporting procedures in MoDOT TM-59. Reported IRI for each segment is the average of both wheel paths. Furnishing inaccurate test results may result in decertification of the inertial profiler operator. Average segment IRIs shall meet the threshold require,ent in Table 1.

610.4.5.2 Quality Assurance Testing. The engineer will perform quality assurance (QA) testing with a MoDOT inertial profiler to verify the QC test results. The engineer shall select a continuous portion of roadway; not adjacent to the beginning or ending of the project limits and free to the degree possible of exempted areas, such as bridges; that constitute at least 10 percent of the project lane-miles, which will be designated as the QA test length. The beginning and ending of the QA test length shall be clearly marked with paint. Both the contractor and engineer shall measure the IRI in both wheel paths for the entire QA test length with their respective inertial profilers. The start and stop of the inertial profiler runs shall be

triggered automatically. The contractor inertial profiler run on the QA test length may constitute the regular QC test result or may be run independently from previous QC test results. The contractor shall provide the electronic file for the QA test length run in .PFF format to the engineer within 24 hours of testing. The IRI value for each segment within the QA test length shall be computed as the average of both wheel paths. The absolute value of the difference between the contractor and engineer IRIs shall be computed for each segment within the QA test length. The average of the absolute values of the IRI difference shall be 8 inches/mile or less. The absolute value of the IRI difference for any single segment shall be 12 inches/mile or less.

610.4.5.3 Areas of Localized Roughness. An area of localized roughness (ALR) is any length of pavement with a continuous 25-foot average IRI measured in the right wheel path that exceeds the maximum threshold set in Table 1. ALRs shall be corrected.

610.4.5.4 Method of Correction. Corrective action to eliminate ALRs and improve the average IRI shall be accomplished by a method approved by the engineer. Diamond grinding may be used for bumps, but the use of an impact device, such as a bush hammer, will not be permitted. Total grinding depth shall be limited to ¼ inch. Satisfactory longitudinal grinding is acceptable as the final surface of the corrected pavements. All corrective work shall be completed prior to determination of pavement thickness. The contractor shall reprofile the corrected lengths to verify smoothness compliance and submit an electronic data file in .PFF format to the engineer within 48 hours after testing.

Table 1

Treatment Type	Posted speed > 45 mph		Posted speed ≤ 45 mph	
	Maximum Segment IRI (in/mi)	Maximum ALR IRI (in/mi)	Maximum Segment IRI (in/mi)	Maximum ALR IRI (in/mi)
Full Depth Pavement or Multi-Lift Overlay > 3-inches	80.0	125.0	80.0	175.0
Multi-Lift Overlays ≤ 3-inches	Posted speed > 45 mph and AADT > 3500		Posted speed ≤ 45 mph or AADT ≤ 3500	
	Maximum Segment IRI (in/mi)	Maximum ALR IRI (in/mi)	Maximum Segment IRI (in/mi)	Maximum ALR IRI (in/mi)
	80.0	125.0	125.0	175.0

610.4.5.5 Method of Correction. Corrective action to eliminate ALRs and improve the average IRI shall be accomplished by a method approved by the engineer. Diamond grinding may be used for bumps, but the use of an impact device, such as a bush hammer, will not be permitted. Total grinding depth shall be limited to ¼ inch. The final surface texture of corrected pavement shall be comparable to adjacent sections that do not require correcting. Satisfactory longitudinal grinding is acceptable as the final surface of the corrected pavements. All corrective work shall be completed prior to determination of pavement thickness.

610.4.6 Multi-treatment Overlays. These construction procedures apply to pavement treatments described in Sec 610.1 (c).

610.4.6.1 Quality Control Testing. The requirements are the same as Sec 610.4.5.1, except that segment average IRIs shall meet the threshold requirements for multi-lift overlays less than or equal to 3 inches in Table 1.

610.4.6.2 Quality Assurance Testing. The requirements are the same as Sec 610.4.5.2.

610.4.6.3 Areas of Localized Roughness. All ALRs, defined in Sec 610.4.5.3 exceeding 175.0 inches/mile shall be corrected.

610.4.6.4 Method of Correction. Corrective action to eliminate ALRs and improve the average IRI shall be accomplished with a method approved by the engineer. Diamond grinding bumps shall only be permitted for a 1½ inch or greater single lift overlay. Grinding depth shall be limited to ¼ inch. The contractor shall reprofile the corrected lengths to verify smoothness compliance and submit an electronic data file in .PFF format to the engineer within 48 hours after testing.

610.4.7 Single Lift Overlays. These construction procedures apply to pavement treatments described in

Sec 610.1 (d).

610.4.7.1 Pre-Construction Quality Control Testing. Prior to performing any surface work or pavement repairs, the contractor shall profile the right wheel path in accordance with TM-59. This control profile will serve as the baseline for calculating percent improvement for the project.

610.4.7.2 Post-Construction Quality Control Testing. As soon as practical after resurfacing, the contractor shall profile the right wheel path again. The same stationing shall be used to ensure a direct comparison with the pre-construction profile.

610.4.7.3 Post-Construction Quality Assurance Testing. The requirements are the same as Sec 610.4.5.2, except that the testing shall only be performed in the right wheel path.

610.4.7.4 Method of Correction. Corrective action to improve the average IRI shall be accomplished with a method approved by the engineer. Diamond grinding bumps shall only be permitted for a 1½ inch or greater single lift overlay. Grinding depth shall be limited to ¼ inch. The final surface texture of corrected pavement shall be comparable to adjacent sections that do not require correcting.

610.4.8 Marred Surface Area. Any area of a segment that has corrective diamond grinding performed without grinding the entire segment shall be defined as a marred surface area.

610.5 Basis of Payment.

610.5.1 Fixed Value Improvement. The following basis of payment procedures shall apply to all pavement treatments described in Sec 610.1 (a), (b) and (c).

610.5.1.1 Smoothness Adjustment. Smoothness adjustments will be paid per segment based on the IRI before any corrections, except for the allowances in Sec 610.5.1.4. Any segment with an IRI above the maximum limit in Tables 2 and 3 must be corrected through a method approved by the engineer to achieve the desired smoothness. When paving widths are greater than the travel lane widths, incentive payment will apply to the driving lane design width only.

610.5.1.2 Incentives. Incentive payment for smoothness shall be based on either Table 2 or Table 3. Table 2 shall be used for all pavements, having a final posted speed greater than 45 mph, except multi-lift overlays less than or equal to 3 inches on routes with AADT less than or equal to 3500 and multi-treatment overlays on routes with AADT less than or equal to 3500. Table 3 shall be used for pavements having a final posted speed of 45 mph or less and multi-lift overlays less than or equal to 3 inches on routes with AADT less than or equal to 3500 and multi-treatment overlays on routes with AADT less than or equal to 3500 at any posted speed. Constant-width acceleration and deceleration lanes shall be considered as mainline pavements.

Table 2	
International Roughness Index, Inches Per Mile	**Percent of Contract Price**
40.0 or less	105
40.1 - 54.0	103
54.1 - 80.0	100
80.1 or greater	100[a]

Table 3	
International Roughness Index, Inches Per Mile	**Percent of Contract Price**
70.0 or less	103
70.1- 125.0	100
125.1 or greater	100[b]

[a]After correction to 80.0 inches per mile or less.
[b]After correction to 125.0 inches per mile or less.

610.5.1.3 Segment Correction. If the contractor elects to diamond grind an entire segment and the

corrected surface drops below the maximum IRI limits in the designated Table, then the contractor cannot receive any incentives, but the marred surface area deductions for that segment will be waived.

610.5.1.4 Section Correction. If the contractor elects to diamond grind an entire section then all segments within the section will be eligible for their respective incentives and the marred surface area deductions for that section will be waived.

610.5.2 Percent Improvement. The following basis of payment procedures shall apply to all pavement treatments described in Sec 610.1 (d).

610.5.2.1 The contract price for resurfacing will be adjusted based on the improvement in profile index according to Table 4 for each segment with an initial IRI greater than 60 inches per mile. Any segment with an initial IRI less than or equal to 60 inches per mile shall receive no percent improvement price adjustment if the segment IRI after placement of the overlay is also less than or equal to 60 inches per mile. Any segment with an initial IRI less than or equal to 60 inches per mile that has an IRI greater than 60 inches per mile after placement of the overlay shall be paid at 97 percent of the contract unit price for pavement, but no correction shall be required.

Table 4

Percent Improvement (Change in IRI / Initial IRI) X 100	Percent of Contract Unit Price For Pavement
35.0 or greater	103
20.0 to 34.9	100
0.0 to 19.9	97[c]

[c]After correction to 0.0 or greater

610.5.3 Marred Surface Deductions. A minimum deduction of 20 percent of the contract unit price of the paving quantities will be made for marred surface areas as defined in Sec 610.4.7. The deduction will be applied to an area of pavement extending from edge of the pavement to a longitudinal joint or between longitudinal joints in that section of pavement affected. If the length of the section affected is less than 10 feet, the deduction will be computed for 10 feet.

610.5.4 Testing Cost. The contract unit price for pavement will be considered as full compensation for all items entered into the construction of the pavement including the cost of smoothness testing.

610.5.5 Dispute Resolution. Any dispute between the engineer and contractor regarding IRI QC/QA comparisons that cannot be settled at the project office level shall be arbitrated with the MoDOT reference profiler per the test procedure in TM-59. The results of the reference profiler shall be binding for the engineer and contractor.