April 26, 2012

# REVISION OF SECTION 105

**HOT MIX ASPHALT PAVEMENT SMOOTHNESS**

**NOTICE**

This is a standard special provision that revises or modifies CDOT’s *Standard Specifications for Road and Bridge Construction.* It has gone through a formal review and approval process and has been issued by CDOT’s Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT’s Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

**Instructions for use on CDOT construction projects:**

Use on all projects having HMA pavement. The designer will specify the roadway pavement smoothness category in the General Notes if it is not HRI Category II. The instructions for determining the pavement smoothness category and traffic control for the Department’s Quality Assurance portion of this specification are in Design Bulletin 2011-3.

Note: This specification requires a Force Account item for incentive payment.

Section 105 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 105.07 and replace with the following:

**105.07 Conformity to Roadway Smoothness Criteria of HMA.** Roadway smoothness testing and corrective work shall be performed as described below. The pavement smoothness category shall be HRI Category II unless shown on the plans.

1. *Smoothness Quality Control Testing.* 
   1. The Contractor shall perform Smoothness Quality Control (SQC) testing. The test results shall be submitted to the Engineer within 48 hours of completion. SQC test results shall show the Half Car Roughness Index (HRI) for each 0.10 mile section and shall show the results for localized roughness.

All traffic control costs associated with SQC testing will be paid for in accordance with Section 630.

SQC testing shall be performed on the first 2,000 tons for the final layer.

SQC testing shall be performed using the Contractor’s inertial profiler, pursuant to the methods described in subsection 105.07(b) and in accordance with the manufacturer’s recommendations. The Contractor’s Profiler shall be certified according to CP 78. A list of certified profilers is located at http://www.dot.state.co.us/DesignSupport/.

Production shall be suspended if SQC testing indicates that corrective work is required in accordance with subsection 105.07 (c). If the SQC data becomes available after production has started for the day, suspension will begin at the end of that production day. Production will remain suspended until the problem is identified and corrected. Each time production is suspended, corrective actions shall be proposed in writing by the Contractor. Production will not be allowed to resume until the proposed corrective actions have been accepted by the Project Engineer in writing.

When production resumes, the Contractor shall profile the first 2,000 tons of HMA. The conditions above for suspension of work will apply.

2. The finished transverse and longitudinal surface elevation of the pavement shall be measured using a 10 foot straightedge. Areas to be measured will be directed by the Engineer. The Contractor shall furnish an approved 10 foot straightedge, depth gauge and operator to aid the Engineer in testing the pavement surface. Areas showing high spots of more than 3/16 inch in 10 feet shall be marked and diamond ground until the high spot does not exceed 3/16 inch in 10 feet.

1. *Initial Smoothness Acceptance Testing.*  The Contractor shall perform Smoothness Acceptance Testing (SA) which will be used for acceptance and calculation of incentive and disincentive adjustments.

All traffic control costs associated with SA testing will be paid for in accordance with Section 630.

* + - 1. Longitudinal Pavement Surface Smoothness Acceptance. Pavement surfaces shall be tested and accepted for longitudinal smoothness as described herein.

1. Testing Procedure (General). The longitudinal surface smoothness of the final pavement surface shall be tested by the Contractor in accordance with CP 74 and using the Contractor’s high-speed profiler (HSP). The Contractor’s Profiler shall be certified according to CP 78. A list of certified profilers is located at http://www.dot.state.co.us/DesignSupport/

The HSP instrumentation shall be verified in accordance with CP 74 prior to measurements. The Contractor shall lay out a distance calibration site. The distance calibration site shall be located no more than ten miles from the Project limits. The distance calibration site shall be 1056 feet long and shall be on a relatively flat, straight section of pavement as approved by the Engineer. The site shall have a speed limit equal to the Project’s highest speed limit that allows for the HSP to operate uninterrupted. The limits of the site shall be clearly marked and the distance shall be measured to an accuracy of +/- 3 inches. The Contractor shall provide in writing the site location to the Engineer. The cost of the distance calibration site will not be measured and paid for separately, but shall be included in the work.

The entire length of each through lane, climbing lane and passing lane including bridge approaches, bridge decks and intersections from the beginning to the end of the project shall be profiled in their planned final configuration. Shoulders less than 12 foot in width and medians will not be profiled and will not be subject to incentive/disincentive adjustments. Shoulders with a width of 12 feet or greater, ramps, tapers, turn slots, acceleration lanes and deceleration lanes will be profiled, but will not be subject to incentive/disincentive adjustments. Shoulders with a width of 12 feet or more, ramps, tapers, turn slots, acceleration lanes and deceleration lanes will be evaluated for localized roughness corrective work. The profile of the entire length of a lane shall be taken at one time. However, the Engineer may break a project into sections to accommodate Project phasing.

A sufficient distance shall be deleted from the profile to allow the profiler to obtain the testing speed plus a 300 foot distance to stop and start when required. Incentive/disincentive adjustments will not be made for this area. The final surface of these areas shall be tested in accordance with subsection 105.07(a) 2.

Shoulders less than 12 foot in width and medians constructed as part of this project shall be measured in accordance with subsection 105.07(a) 2.

The profile shall include transverse joints when pavement is placed by the project on both sides of the joint. When pavement is placed on only one side of the joint, the profile shall start 25 feet outside the project paving limits. The profile of the section of pavement 25 feet outside the paving limits to 25 feet inside paving limits will not be subjected to incentive or disincentive adjustments, but will be evaluated for localized roughness.

The profile of the area 25 feet each side of every railroad crossing, cattle guard, bus pad, manhole, gutter pan and intersection (where there is a planned breakpoint in the profile grade line in the direction of traffic) shall be deleted from the profile before the HRI is determined. Incentive/disincentive adjustments will not be made for these areas. Areas deleted from the profile shall be tested in accordance with subsection 105.07(a) 2.

When both new pavement and a new bridge or new bridge pavement are being constructed in a project, the profile of the area 25 feet each side of the bridge deck shall be deleted from the profile before the HRI is determined. Incentive/disincentive adjustments will not be made for this area. Areas deleted from the profile shall be tested in accordance with subsection 105.07(a) 2. The bridge deck will be evaluated for localized roughness. Corrective work required in these areas will not be measured and paid for separately, but shall be included in the work. For all other projects, the profile of the area 25 feet each side of the bridge deck shall be deleted from the profile before the HRI is determined. Incentive/disincentive adjustments will not be made for this area. If the Engineer determines that corrective work is required in this area, payment will be made in accordance with subsection 109.04.

The Contractor shall notify the Engineer in writing at least five working days in advance of his intention to perform SA testing. The Contractor shall profile the Project within 14 days after the completion of paving operations. The Engineer will witness the SA profiling and take immediate possession of the SA data.

The Contractor shall not perform any corrective work that will affect the pavement smoothness for ten working days after completion of the SA testing or as approved by the Engineer. This time is to allow for the Department to analyze the data and perform smoothness verification testing.

1. Smoothness Testing Procedures. The Contractor shall mark the profiling limits and excluded areas. The Engineer will verify that the Contractor's marks are located properly. The Contractor shall use traffic cones with reflective tape or reflective tape on the pavement at the beginning and end of each lane for triggering the start and stop locations on the profiler and at any other location, where portions of the profile are being deleted. These locations shall be marked with temporary paint so that the Department’s profiler uses the same locations for smoothness verification testing.

The Contractor shall clear the lanes to be tested of all debris before profiling.

The Contractor shall submit a Method for Handling Traffic (MHT) to the Engineer for approval at least five days in advance of SA testing. The MHT shall detail the methods for traffic control that will allow for continuous non-stop profiling of each lane to be profiled at a minimum speed of 15 mph. The Contractor shall provide the traffic control in accordance with the approved MHT.

Each lane shall be profiled at least once. Profiling shall be at a constant speed (+/- 5 mph of the distance calibration speed ) with a minimum speed of 15 mph and a maximum speed of 70 mph. Shoulders with a width of 12 feet or more, ramps, tapers, turn slots, acceleration lanes and deceleration lanes shall be profiled**.** The profile shall be taken in the planned direction of travel. The left and right wheel paths shall be profiled simultaneously. The collected profiles shall be turned over immediately to the Engineer and will be analyzed using CP 74.

1. The Department will determine a HRI for each 0.1 mile section or fraction thereof of completed pavement. The HRI consists of the left and right wheel path's profile passed through the International Roughness Index (IRI) filter.

The Contractor’s SA test results will be available within ten working days of the completion of SA testing. The Engineer will give the Contractor a report that will include the lane profiled, the HRI in 0.10 mile increments and a summary of areas requiring corrective work. The Engineer may determine that it is necessary for the Contractor to re-profile a lane.

Areas requiring corrective work will be determined according to subsection 105.07(c) 1.

Sections less than 0.01 miles in length shall not be subject to corrective work as specified by Table 105-6. Sections less than 0.01 miles in length shall be included in the Localized Roughness determination.

1. Acceptance and incentive/disincentive adjustments for pavement smoothness will be made on a square yard basis in accordance with the following:

Incentive and Disincentive adjustments will be based on the HRI for each 0.1 mile section or fraction thereof. Incentive/Disincentive adjustments for Pavement Smoothness will be made in accordance with Table 105-6**.** Sections less than 0.01 miles in length will not be subject to disincentives.

**Table 105-6**

# HMA PAVEMENT SMOOTHNESS (INCHES/MILE)

**HALF-CAR ROUGHNESS INDEX**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pavement Smoothness Category | Incentive Payment ($/sqyd) | No Incentive or Disincentive | Disincentive Payment ($/sqyd) | Corrective Work Required |
| **I** | When HRI ≤ 40.0 | When HRI ≥ 63.0 and ≤ 72.0 | When HRI > 72.0 and < 90.0 | When HRI > 90.0 |
| I = $1.28 | I = $0.00 | I = 5.12 – 0.07111 x HRI |  |
| When HRI > 40.0 and < 63.0 |  | When HRI ≥ 90.0 |  |
| I = 3.51 – 0.05565 x HRI |  | I = – $1.28 |  |
| **II** | When HRI ≤ 35.0 | When HRI ≥ 58.0 and ≤ 67.0 | When HRI > 67.0 and < 85.0 | When HRI > 85.0 |
| I = $1.28 | I = $0.00 | I = 4.76 – 0.07111 x HRI |  |
| When HRI > 35.0 and < 58.0 |  | When HRI ≥ 85.0 |  |
| I = 3.23 – 0.05565 x HRI |  | I = – $1.28 |  |
| **III** | When HRI ≤ 45.0 | When HRI ≥ 70.0 and ≤ 80.0 | When HRI > 80.0 and < 100.0 | When HRI > 100.0 |
| I = $1.28 | I = $0.00 | I = 5.12 – 0.064 x HRI |  |
| When HRI > 45.0 and < 70.0 |  | When HRI ≥ 100 |  |
| I = 3.584 – 0.0512 x HRI |  | I = - $1.28 |  |  |  |  | When HRI > 80.0 and < 100.0 | When HRI > 100.0 |

(c) *Corrective Work.*

The Department will analyze the SA testing for acceptance and indicate areas requiring corrective work in accordance with subsection 105.07(b). Corrective work shall be proposed in writing by the Contractor. Corrective work shall not be performed until approved in writing by the Engineer. The Contractor shall not perform any corrective work on the final layer until after the Engineer returns the results of the Initial Smoothness Acceptance testing and after the Department’s Smoothness Verification testing, if performed. The Contractor shall perform corrective work in the areas indicated by the SA testing.

Corrective work on lower layers shall be at the Contractor’s discretion.

The Contractor shall profile the roadway to verify the required corrective work has been completed.

If the Contractor elects to perform corrective work prior to the completion of initial SA testing, the entire 0.10 mile section, or fraction thereof, will not be eligible for incentive payment, but will be eligible for disincentive. The Engineer will not modify the limits of the 0.10 mile sections to group corrective work areas in an effort to reduce the number of sections impacted by this decision.

The Contractor may elect to perform additional corrective work to reduce or eliminate the disincentive payment for each 0.1 mile section or fraction thereof after the initial SA testing and the Department’s verification testing.

The criteria for determining if a 0.1 mile section or fraction thereof requires corrective work is specified in Table 105-6. In addition to determining if a 0.1 mile section or fraction thereof requires corrective work, the profiles shall be analyzed for areas of Localized Roughness.

Localized Roughness. The profiles shall be analyzed to determine where areas of localized roughness occur. The profile shall be summarized using the continuous HRI reporting system using an averaging length of 25 feet. The FHWA’s ProVal (Version 3.2 or later) software will be used to generate the continuous HRI report. ProVal can be downloaded at [http://www.roadprofile.com](http://www.roadprofile.com/).

Areas of localized roughness are determined to be where the continuous HRI report exceeds the values in Table 105-9. Areas of localized roughness greater than 15.0 feet in length shall be considered deficient, and require corrective work.. Areas of localized roughness less than 25 feet in distance that contain a valve box shall be tested in accordance with subsection 105.07 (a) 2. for corrective work.

# Table 105-9

**CONTINUOUS HRI USING 25 FOOT AVERAGING FOR LOCALIZED**

**ROUGHNESS CORRECTIVE WORK ON HMA PAVEMENTS**

|  |  |
| --- | --- |
| HRI  SMOOTHNESS  CATEGORY | HRI In/mile |
| I | 135.0 |
| II | 125.0 |
| III | 150.0 |

1. Corrective Methods. Corrective work shall consist of diamond grinding, an approved overlay, or removal and replacement.

Corrective work shall conform to of one of the following conditions:

1. Removal and Replacement. The pavement requiring corrective work shall be removed, full width of the lane and the full thickness of the layer in accordance with subsection 202.09.

The removal area shall begin and end with a transverse butt joint, which shall be constructed with a transverse saw cut perpendicular to centerline. Replacement material shall be placed in sufficient quantity so the finished surface conforms to grade and smoothness requirements. Sections removed and replaced shall be at least 0.20 miles in length.

1. Overlay. The overlay shall cover the full width of the pavement including shoulders. The area overlaid shall begin and end with a transverse butt joint, which shall be constructed with a transverse saw cut and asphalt removal. All material shall be approved hot bituminous mixtures that meet all contract requirements. The overlay shall be placed so that the finished surface conforms to grade and smoothness requirements. The overlay area shall be compacted to the specified density. The overlay thickness shall be equivalent to that of the final layer in accordance with the Contract. Sections overlaid shall be at least 0.20 miles in length.
2. Diamond Grinding. Grinding shall not reduce planned pavement thickness by more than 0.3 inches. The entire ground area of the final pavement surface shall be covered with a Tack Coat conforming to Section 407 (CSS-1h at 0.1 gallons per square yard of diluted emulsion; the emulsion shall be diluted with water at the rate of 50 percent water and 50 percent emulsion) when grinding is complete. Cores shall be taken to verify that minimum pavement thicknesses have been maintained. A minimum of one core shall be taken every 100 cumulative feet or fraction thereof per lane of diamond grinding, as directed by the Engineer. Coring shall be at the Contractor’s expense.
3. *Final Smoothness Acceptance Testing.* After the Contractor has completed the required corrective work and any additional corrective work, the Contractor shall retest the pavement in accordance with subsection 105.07(b). If the Contractor requests to do additional corrective work to reduce disincentive after Final SA Testing, the Contractor shall perform an additional Final SA Testing for the project. A charge of $500 will be assessed to the Contractor for each additional Final SA Testing. Time count will be charged pursuant to contract requirements during the time period required for all Final SA Testing. Delays associated with additional Final SA Testing will be considered non-excusable and non-compensable.

The Contractor shall notify the Engineer pursuant to 105.07(b) to schedule the final SA testing.

Final acceptance and incentive/disincentive adjustments for pavement smoothness will be made on a square yard basis in accordance with the following:

Incentive payments will be based on the HRI for each 0.1 mile section or fraction thereof from the Contractor’s initial SA testing. Those sections which earned incentives or full payment based on the initial SA testing will not be re-evaluated for incentive after final SA testing.

The disincentive payment will be based on the HRI for each 0.1 mile section or fraction thereof from the Contractor’s Initial SA testing or the Contractor’s Final SA testing, whichever is less. Those sections which had disincentive levels indicated by the initial SA, will be re-evaluated for disincentive. The Contractor may eliminate all disincentives on those 0.1 mile sections; however, no incentives may be earned in these areas, regardless of the final smoothness.

1. *Department Smoothness Verification Testing (SV).*  The Department may elect to perform smoothness verification (SV) testing using the Department’s inertial profiler, with the methods described in subsection 105.07(b). The Engineer will notify the Contractor of the Department's intention to perform SV testing. All traffic control costs associated with Department SV testing will be paid for by the Department in accordance with Section 630.

The Contractor’s SA test results will be compared to the Department’s SV test results. The Contractor’s SA test results will be considered acceptable and will be used for incentive/disincentive payment if the following criteria are met:

1. The difference in HRI for a 1/10 mile section is less than 6.1 inches/mile for a minimum of 90 percent of the 1/10mile sections for each lane.
2. The difference in average HRI for each lane is less than 6.1 inches/mile.
3. The difference in the length of each lane is less than 0.2 percent

When the Contractor’s SA test results are not considered acceptable, the Department’s SV test results will be used for incentive/disincentive payment and the Contractor’s profiler certification will be evaluated pursuant to CP 78. The Department will have 30 days to complete this evaluation.

The Contractor will be assessed a charge of $1,000 for SV testing when the Contractor’s SA test results are not considered acceptable.

1. *HMA Recycling Treatment’s, Thin Lifts’ and Urban Rehabilitation treatment’s smoothness criteria.* When HMA recycling, urban rehabilitation treatments or when only one layer less than 1.5 inches of HMA Pavement is placed without an intermediate treatment are constructed as the final riding surface, the following shall be used for acceptance:

An HRI for each 0.1 mile section shall be determined on the original pavement surface prior to beginning the work.

An HRI for each 0.1 mile section shall be determined on the pavement surface after the work is complete.

When a 0.1 mile section has a final HRI greater than 80.0 in/mile and the final HRI is greater than the HRI prior to performing the work, that 0.1 mile section shall be corrected by a method approved in writing by the Engineer. Corrective work shall be such that the resulting final HRI is equal to or less than the initial HRI or 80.0 in/mile, whichever is greater. All costs associated with corrective work shall be at the Contractor’s expense, including but not limited to traffic control, additional hot mix asphalt, grinding and milling.

Incentive/disincentive adjustments for smoothness will not be made for these treatments.

The pavement smoothness for HMA Recycling Treatments and Thin Lifts that will be overlaid with a final riding surface will not be evaluated by the Department for acceptance.