STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION

PAVEMENT SMOOTHNESS GUIDELINES

Construction Administration of Hot Mix Asphalt and Concrete Pavement Smoothness

August 2023

Disclaimer

These *Pavement Smoothness Guidelines* for the Construction Administration of *Hot Mix Asphalt and Concrete Pavement Smoothness* are intended for use by California Department of Transportation (Caltrans) personnel and the construction industry.

These guidelines are not contract documents and impose no obligations or requirements on contractors. The guidelines are prepared to serve as a general reference for Caltrans and industry personnel in the contract administration of pavement smoothness specifications. Resident engineers and other Caltrans personnel who administer Caltrans contracts must never attempt to use these guidelines as a substitute or supplement to the *Standard Specifications* or other contract requirements and provisions.

Use these guidelines with the current Section 36-3, “Pavement Smoothness”; Section 39, “Asphalt Concrete”; Section 40, “Concrete Pavement”; and Section 42, “Groove and Grind Concrete,” of the Caltrans *Standard Specifications*. The Caltrans *Standard Specifications* can be found at:

https://dot.ca.gov/programs/design/ccs-standard-plans-and-standard-specifications

Foreword

These *Pavement Smoothness Guidelines for the Construction Administration of Hot Mix Asphalt and Concrete Pavement Smoothness* were developed by the Caltrans Division of Construction. They are based on several components in Division V, “Surfacings and Pavements,” including requirements in Section 36, “General”; Section 39, “Asphalt Concrete”; Section 40, “Concrete Pavement”; and Section 42, “Groove and Grind Concrete,” of the *Standard Specifications*. These guidelines for contract administration provide reference information and submittal requirements to document pavement smoothness performance for hot mix asphalt and concrete pavements. Information includes an overview of specifications and incentive and disincentive analysis.

These guidelines are organized by chapters in an order that mimics the way that training is presented to Caltrans personnel. This allows participants in the Construction Administration of Asphalt Concrete and Concrete Pavement Smoothness training to follow along and make notes in their copies of these guidelines.

Chapter 1 provides a list of applicable terms and definitions. Chapter 2 is an overview of the procedure. Chapter 3 discusses the roles and responsibilities of those accountable for smoothness. Chapter 4 details the process for administering the smoothness specification for both concrete and asphalt concrete pavement. Chapter 5 provides an overview of the dispute process. In the appendixes, the reader will find additional information on the tools, equipment, and instructions to assist with administering smoothness specifications.

Questions on these guidelines can be directed to:

Division of Construction
Office of Construction Standards
5900 Folsom Boulevard
Sacramento, California 95819

Attn: Deborah Yost (Concrete) or Mirak Mehari (Hot Mix Asphalt)

Email:

Deborah.Yost@dot.ca.gov
Mirak.Mehari@dot.ca.gov

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Chapter 1: Terms and Definitions

Terms and Definitions

Area of Localized Roughness: The continuous 25-foot moving average of the International Roughness Index (IRI) values along a single wheel path.

Automated Pavement Condition Survey: The collection of pavement condition data collected by customized vehicles fitted with sensing equipment that travel on the roadway at or near highway speed.

Baseline MRI: Mean roughness index (MRI) of existing pavement segments taken after execution of any structural repair work, such as remove and replace asphalt concrete or leveling courses.

Continuously Reinforced Concrete Pavement: Concrete pavement with continuous longitudinal steel reinforcing bars and no transverse joints.

Exist MRI: MRI of existing pavement taken before any work is performed.

Final MRI: MRI taken after corrective grinding is complete or final smoothness corrections have been made, if necessary, before placing open-graded friction course (OGFC) layers if required.

"Final O" is the MRI of OGFC segments after paving and performing any smoothness corrections.

Global Positioning System Files: Additional Global Positioning System (GPS) information recorded by the inertial profiler along the route must be submitted in a separate file using a GPX exchange file format (.GPX). These files can be opened and viewed using Google Earth, the GPX Viewer in Chrome, as well as other mapping applications.

Inertial Profiler Equipment and Operators: A piece of equipment used to record the profile elevations of the wheel tracks. This equipment must be certified yearly and be operated by a person who has been certified to run the same make and model.

Information on the "Inertial Profiler Certification Program," along with a list of certified inertial profilers and operators, can be found at:

https://dot.ca.gov/programs/engineering-services/inertial-profiler-certification-program

Inertial Profiles: The Pavement Profile Standard file format, indicated by filename extension PPF, is a binary-based file format created for ProVAL. It is portable, stable, and upgradeable. The ASTM International profile data file specification is based on this format.

PPF files submitted by the contractor are profile elevations of each wheel track. These PPF files include one elevation value every inch along each wheel track, as well as GPS coordinate information for the start, stop, and event markers. They do not include values related to the IRI.

Inertial Profiler Certification Program: A program intended to capture and manage the annual certification of inertial profiler operators and equipment in accordance with California Test 387, "Method of Test for Operation, Calibration and Operator Certifications of Inertial Profilers." The Inertial Profiler Certification Program (IPCP) is not a training program.

Information on the program can be found at:

https://dot.ca.gov/programs/engineering-services/inertial-profiler-certification-program

International Roughness Index: This is the roughness index most commonly obtained from measured longitudinal road profiles. It is calculated using a quarter-car vehicle math model whose response is accumulated to yield a roughness index with units of slope, such as inches per mile.

Jointed Plain Concrete Pavement: Unreinforced cast-in-place concrete pavement designed with doweled transverse joints and tied longitudinal joints to control cracking as well as vertical and horizontal movement.

Keyhole Markup Language Format Files: A file with the .KML file extension is a Keyhole Markup Language file. A file with the .KMZ file extension is a compressed file that contains a KML file. KML files can store locations, image overlays, video links, and modeling information such as shapes, 3D images, and points. Various computer applications display KML, including Google Earth, NASA WorldWind, ESRI ArcGIS Explorer, Adobe Photoshop, AutoCAD, and Yahoo!

Mean Roughness Index: A single average value determined from a fixed interval of each 0.1 mile, or portion thereof, of roadway. The Mean Roughness Index value for each interval is an average of all the International Roughness Index (IRI) values from both wheel paths in that interval.

Mean Roughness Index Zero: Mean Roughness Index Zero ($MRI_{0)}$ applies to smoothness of hot mix asphalt (HMA) pavement surfaces and does not apply to concrete pavement. MRI_0 is the lower MRI value from the "EXIST" and "BASELINE" profiles, except when segment corrections are used, for which MRI_0 is the EXIST MRI value.

Pave MRI: MRI taken after paving and before any corrections.

"PAVEO" is the MRI of OGFC segments after paving OGFC before performing any smoothness corrections.

ProVAL: ProVAL (Profile Viewing and Analysis) is an engineering software application that allows users to view and analyze pavement profiles. ProVAL is a product sponsored by the U.S. Department of Transportation, Federal Highway Administration (FHWA), and the Long-Term Pavement Performance program.

Segment Correction: Segment Correction is a bid item that requires grinding or micro milling of segments by diamond grinders, micro milling machines or alternative method of correction authorized by the engineer. The segment locations are shown on the plans. Exact widths and locations of corrections within the 0.1-mile segments are determined by the contractor. The contractor submits to the engineer a correction plan that identifies the intended depths, widths, and lengths of correction locations throughout each 0.1-mile segment. Corrected surfaces are allowed to remain open to traffic for as long as 7 days. The contractor identifies the segment correction segments on the smoothness payment adjustment spreadsheet. Final pavement surface must comply

with section 39-2.01A(4)(i)(iii)(C). “Pay Adjustments for Pavement Constructed on Existing Pavement Surfaces,” of the *Standard Specifications*.

Semi-Permanent Reference Point: When established properly, a semi-permanent reference point (SPRP) will be set in the field at the start and end points and its location recorded in all subsequent inertial profiler runs. The SPRPs are identified via station and offset and GPS coordinates in the submittal specified by Section 36-3.01C(5), “Smoothness Quality Control Plan” of the *Standard Specifications*. The station and offset of the SPRP will be established during the contractor’s first profile run required in the contract.

Wheel Paths: Parallel lines three feet on each side of the center of a traffic lane. Left and right wheel paths are based on the direction of travel.

Chapter 2: Construction Administration Procedures

Incentive and Disincentive Smoothness Specifications

The Construction contract administration process follows four general steps.

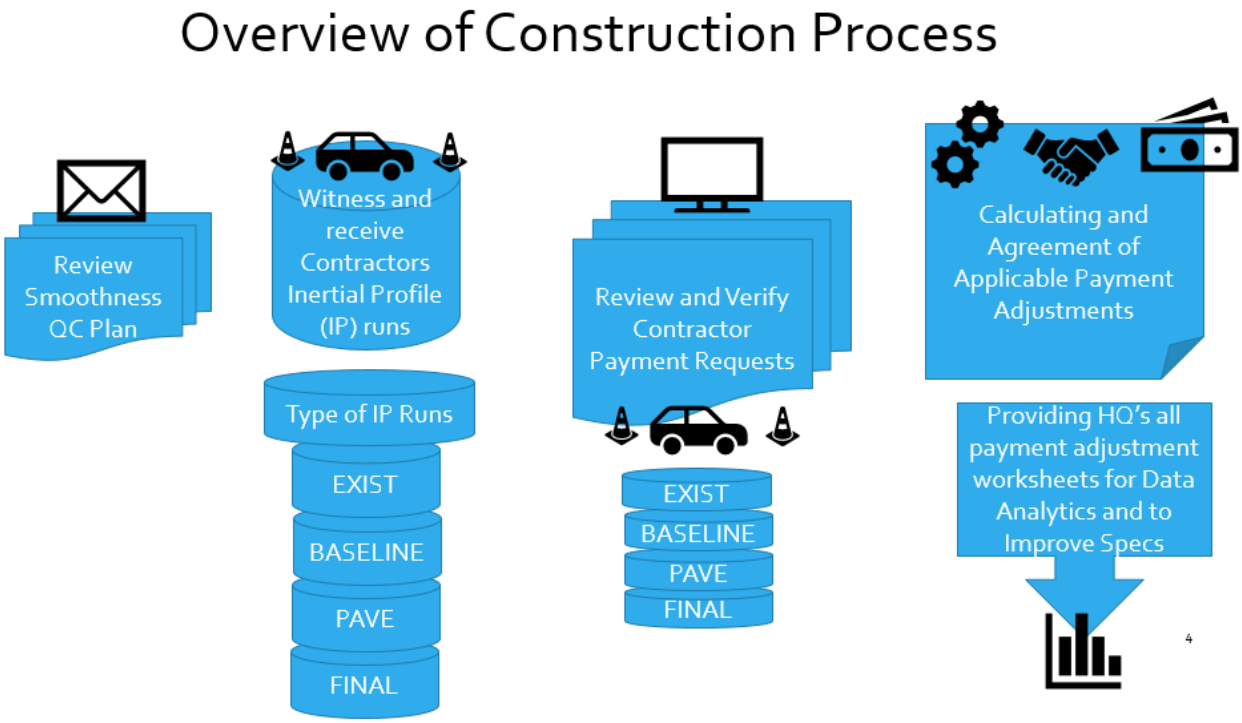


Figure 2-1: Overview of the Construction contract administration process for smoothness specifications

Step 1. Review the Smoothness Quality Control Plan

The quality control plan will:

- Make sure all measured profiles line up with the contractor's first required profile, the EXIST profile on HMA and grind existing concrete pavement projects, and the PAVE profile on new concrete pavement projects. Successful implementation of these specifications depends on how well all profiles taken during the contract align with the contractor's first required profile—including the engineer's verification profiles.
- Document certifications, contacts' names, phone numbers, and responsibilities.
- Contain a layout plan sheet, a map of the project so that all inertial profiler operators use the same stationing.
- Establish begin and end semi-permanent reference points.
- Document distance measuring instrument (DMI) stations, GPS coordinates, photos, KML files.

The quality control plan is an action submittal. The resident engineer has 15 days to review it in accordance with Section 5-1.23B, “Action Submittals,” of the *Standard Specifications*.

Step 2. Witness and Receive Contractor’s Inertial Profile Runs

- Engineer witnesses contractor profiles: The engineer must witness inertial profiler calibration and verification tests and contractor inertial profile smoothness measurements.
- All profiles must:
    - Be submitted directly to the resident engineer on an electronic storage device within 12 hours or on the same day of completing the profiles. These profiles will later be compared to the profiles submitted in the project file (PVP) included as part the contractor’s payment adjustment request.
    - Be submitted via the secure file share.
    - Have their PDF files submitted within 2 working days. Have the PDF file generated by the inertial profiler software. This PDF file lists the collection time and date, data collection software version used, laser serial numbers, low- and high-pass filters setting values, and the 0.1-MRI values. The low- and high-pass filter setting values must be set to zero. See Figure 4-1 for an example of this PDF file, which needs to be submitted within 2 working days.
    - Have coordinated video or images taken at intervals no greater than 52.8 feet (For EXIST and BASELINE profiles only, not required for PAVE or FINAL profiles).

Section 39, “Asphalt Concrete,” of the *Standard Specifications,* requires the contractor to:

- Notify the engineer 10 days before collecting inertial profiler data.
- Allow the engineer 2 days after receipt of data to complete inertial profiler verification of all data except the FINAL inertial profiler data.
- Allow the engineer 10 days after receipt of data to complete verification of FINAL inertial profiler data.

Construction policy requires that the engineer verify the contractor’s inertial profile runs at a minimum frequency of 1 engineer inertial profile run for every 10 contractor profile runs.

Step 3. Receive and Review Contractor Payment Request Submittals

Submittals must include:

- One properly aligned PVP file for each lane, the same file as used to populate the worksheet.
- One smoothness adjustment worksheet for each lane.
- One file for each lane is always required for the EXIST profile; however, stage construction may require BASELINE, PAVE, and FINAL profiles to be “end to end” and not one continuous run through the entire project. When this occurs, the applicable portion of the EXIST profile can be exported as a shorter raw profile data file (“.PPF”).

The resident engineer must review the profile to make sure MRI data in the spreadsheet is a direct export from the ProVAL project file (PVP) containing the same profiles previously submitted by the contractor.

See Appendix F, “Pay Adjustment Example,” of this manual, for further information on reviewing the contractor’s smoothness payment adjustment request.

For training videos on use of the concrete and HMA smoothness adjustment spreadsheets, go to:

https://dot.ca.gov/programs/construction/pavement-smoothness

Step 4. Resident Engineer Makes Payment Adjustments Monthly and Submits Final Payment Adjustment Spreadsheets and Accompanying ProVAL Project Data Files to Caltrans Headquarters

Once a contractor payment request is approved, the resident engineer can process the payment using a change order previously issued for the supplemental fund allotment. Adjustments should be paid monthly for payment adjustments due that month.

All payment adjustment spreadsheets used to make smoothness payment adjustments must be submitted by the resident engineer to headquarters’ email addresses.

Resident engineers must submit the hot mix asphalt pavement or concrete pavement smoothness pay adjustment spreadsheet file used to determine acceptance and the applicable payment adjustments for each lane, as well as the accompanying ProVAL project data files.

Submit these files to the email address for hot mix asphalt pavement or concrete pavement within 10 business days of including the smoothness payment adjustment in the progress estimate. Submit the same files to the email address within 10 business days of approving a contractor’s smoothness acceptance request for grinding existing concrete pavement.

For hot mix asphalt pavement, submit the files to:

Asphalt.Smoothness@dot.ca.gov

For concrete pavement, submit the files to:

Concrete.Smoothness@dot.ca.gov

Data in the payment adjustment spreadsheet will be analyzed and used to further improve the smoothness specifications.

Chapter 3: Roles and Responsibilities

Project (Design) Engineer

The successful implementation of the smoothness specification begins during the design phase. As part of developing the plans, specifications, and estimates (PS&E) package, it is key for the project engineer to identify the semi-permanent reference points, include supplemental funds, and determine if bid items for pre-paving corrections of existing asphalt concrete are included.

Resident Engineer

Administering the smoothness specifications, processing change orders, along with processing payment for incentive and disincentive for smoothness, are responsibilities of the resident engineer. Key tasks of the resident engineer include reviewing the contractor's smoothness quality control plan, assigning staff to witness the contractor's inertial profile runs, scheduling inertial profile verification testing, reviewing, and processing the payment adjustment sheet for payment, and after approving payment adjustments, emailing the completed payment adjustment spreadsheets, and accompanying ProVAL project data files to headquarters. These files need to be submitted to the email address for hot mix asphalt pavement or concrete pavement within 10 business days of including the smoothness payment adjustment in the progress estimate. The resident engineer submits the same files to the email address within 10 business days of approving a contractor's smoothness acceptance request for grinding existing concrete pavement.

Construction Inspector

The inspector is responsible for verifying smoothness during the project by checking that the work is being done in accordance with the layout sheet in the contractor's quality control plan; verifying that semi-permanent reference points are being maintained during construction and recorded in each inertial profile run; and witnessing each smoothness test performed by the contractor to confirm the center of lane is followed. The construction inspector must also prepare daily reports documenting contractor's operation.

Caltrans Inertial Profiler Operator

In general, a minimum of 1 inertial profile verification will be performed for 10 inertial profiler runs by the contractor. The Caltrans inertial profiler operator will work with the resident engineer, once the contractor's quality control plan is approved, to identify the number of profile verifications to be completed and to schedule profile verifications at the appropriate time. The inertial profiler operator records inertial profile runs using the same semi-permanent reference points the contractor defined in the quality control plan. The inertial profiler operator maintains a current inertial profiler certification and logs the required daily calibration and verification tests before each inertial profile run. See Appendix J, "Performing Verification Tests on Inertial Profilers," of this manual, for further information on inertial profiler verification tests.

Contractor

The contractor will perform work in accordance with the contract specifications. In particular, the contractor will be responsible for preparing and implementing the quality control plan and scheduling all inertial profile runs. Before doing the work, the contractor—in the engineer's presence—will conduct the daily calibration tests for the inertial profiler and one annual cross-correlation verification test. The contractor's inertial profiler and operator must be certified, and proof of a valid certification must be provided on an annual basis.

After each profile run is completed, the contractor will submit the required documentation in the timelines listed in the specifications.

Chapter 4: Administration of Pavement Smoothness Specifications

Before Work Begins (Measuring Pavement Smoothness)

- Set up an electronic file structure for the smoothness submittals. You will receive numerous files for various lanes. It is recommended to have at least one folder per route and direction. The PPF, PVP and XLSM file names are long, so abbreviate the file name lengths to the extent possible. This allows the electronic smoothness submittals from the contractor to be organized and avoid exceeding maximum file path names.
- At least 15 days before measuring pavement smoothness with an inertial profiler, contractors must register with the Caltrans' secure file transfer system. If contractors need to obtain information on the registration process, have them send an email request with their contact information to:

  Asphalt.Smoothness@dot.ca.gov for asphalt or

  Concrete.Smoothness@dot.ca.gov for concrete surfaces.
- Review Section 36-3.01D(3)(b)(i), "General," of the *Standard Specifications* and determine which portions of new pavement will be subject to inertial profiler requirements and which portions will be subject to straightedge requirements.
- Discuss pavement smoothness requirements at the preconstruction meeting required for the surfacing or pavement operation. Include the following items in the discussion:
    - Requirements for the smoothness quality control plan
    - Specified naming conventions must be followed for all submitted profiles
    - Inclusion of all bridge approach slabs, bridges, and culverts visible on the roadway surface and at grade intersections in the raw inertial profile data
    - Contactor-marked locations of the beginning and ending stations and leave-outs in order for the engineer to verify final acceptance profiles
- Discuss that a written smoothness quality control plan must be submitted by the contractor to the engineer at or before the preconstruction meeting. The plan must incorporate all of the following elements:
    1. **Organization**: Contact names organizational chart, telephone numbers, current certifications, titles, roles, and responsibilities of personnel monitoring smoothness, collecting profile data, submitting data, pay adjustment requests and reports, and implementation of corrective actions.
    2. **Inertial profiler and operator certification requirements**:
        a. Inertial profiler certification issued by Caltrans within the past 12 months
        b. Manufacturer's instructions and test procedures for calibration and verification of the inertial profiler

c. Operator certification for the inertial profiler issued by Caltrans within the past 12 months

3. **Schedule**: The methods and timing used for monitoring and testing ride quality throughout the placement operation process. An indication of the approximate timing of acceptance testing for the profile operations defined in Section 36-3.01C(3), “Smoothness Corrective Grinding Plan,” of the *Standard Specifications,* in relation to placement operations and stages of construction.

4. **Layout plan**:

   a. Semi-permanent reference points at the beginning and end of the project based on the plans.

   b. For each profile run, define additional semi-permanent reference points for the beginning and end positions of each run.

   c. Position and name of each semi-permanent reference point. These reference points must be outside the traveled way, perpendicular to the starting position of each lane. Where starting positions are adjacent to each other but staggered, there must be separate starting positions. An example of this would be staggered starting positions caused by bridge abutment skew angles.

   d. The semi-permanent reference points used to establish the beginning position of a profile must be based on the EXIST profile run for HMA and grind existing concrete pavement, and the PAVE profile for new concrete pavement. This requires the EXIST profile to be run, semi-permanent reference points marked and tied to the EXIST inertial profile DMI stationing before submitting the smoothness quality control plan. When the EXIST profile run delays the preconstruction meeting, the DMI stationing of the semi-permanent reference points may be estimated, under the condition the layout plan is updated after completing the EXIST profile run. The semi-permanent reference points from the EXIST profile must be labeled in the field and in the pavement profiles using the following naming convention:

XXX-D-L-STA-VAL

In which:

XXX = “Beg” for the beginning of each profile run, “End” for the end of each profile run, “ExB” for the beginning point of the areas excluded from inertial profiler testing, and “ExE” for the end point of the areas excluded from inertial profiler testing.

D = traffic direction, *NB*, *SB*, *WB*, or *EB.*

L = lane number from left to right in the direction of travel, such as “1,” “2,” or “3.”

STA = station to the nearest foot, such as 10+20. Do not use postmiles. For HMA and Grind Existing Concrete, the station is based on the DMI reading from the EXIST inertial profile. For new concrete pavement, the station is based on the DMI reading from the PAVE profile.

VAL = use “INC” where the value of stationing in the pavement profile data file (*.PPF) will increase in the direction of travel. Use “DEC” where the absolute

value of the stationing in the pavement profile data file (*.PPF) will decrease in the direction of travel.

Use the same label name regardless of the stage of the profile.

e. For each semi-permanent reference point, include a KMZ file with:

   i. Color photographs clearly displaying the physical label used to define the semi-permanent reference points.

   ii. Listing of GPS coordinates.

f. Semi-permanent reference points, wherever possible, must be recorded by inertial profilers using electronic eye readings of reflectors.

ProVAL Training

In advance of the contractor's start of surfacing or paving operations, verify that project staff is trained and knowledgeable in the use of ProVAL computer software. ProVAL is used to view and analyze raw profile data as well as to review and generate PDF reports. ProVAL is on Caltrans' Approved Software List, and online training is available for Caltrans employees on Onramp under the Division of Maintenance in the pavement program webpage at:

https://maintenance.onramp.dot.ca.gov/paveprogram/pavement-smoothness

ProVAL online training and software are available at:

https://dot.ca.gov/programs/construction/pavement-smoothness

http://www.roadprofile.com

Step-by-step instructions for using ProVAL to validate a contractor's smoothness payment adjustment request submittals are provided in Appendix F, "Payment Adjustment Example," of this manual.

Videos on the steps the contractor takes to complete the smoothness payment adjustment request are available at:

https://dot.ca.gov/programs/construction/pavement-smoothness

During the Course of Work (Measuring Pavement Smoothness)

Verify that the contractor plans and measures smoothness profiles based on the type of work using Table 4-1, "Profiles Needed by Smoothness." These inertial profiles are required in accordance with the specification to determine acceptance and any payment adjustments.

Table 4-1 — Profiles Needed by Smoothness

Profile	HMA pavement constructed on existing pavements	New HMA pavement alignment or new realignment	Concrete Target MRI 60/67.5/75	Grind existing concrete pavement Percent Improvement
EXIST	X			X
BASELINE	X			X
PAVE	X	X	X	
FINAL	X	X	X	X

- For **asphalt concrete**, smoothness measurements are required from the contractor for the following:
    - Existing asphalt concrete surface before performing any work on the surface. The contractor must provide the engineer the result labeled as the "EXIST" inertial profiler data file and notify the engineer if the MRI results vary by more than 10 percent from the MRI information provided by Caltrans at the time of advertisement. For projects suspended for more than 30 days, the contractor must measure the smoothness of the existing surface that has not received an HMA overlay and provide the engineer the result labeled as "EXISTR" inertial profiler data file. The contractor will use the EXISTR profile as the EXIST profile.
    - Existing pavement segments if structural repairs, such as remove and replace asphalt concrete or leveling courses, are made. The contractor must provide the engineer the result labeled as "BASELINE" inertial profiler data file.
    - Pavement segments exclusive of OGFC on new HMA before performing any HMA smoothness corrections. The contractor must provide the engineer the result labeled as "PAVE" inertial profiler data file.
    - Pavement segments exclusive of OGFC on new HMA after performing any HMA smoothness corrective work. The contractor must provide the engineer the results labeled as "FINAL" inertial profiler data file. If there is no corrective work in the segment, the contractor will use the "PAVE" inertial profiler data as the "FINAL" inertial profiler data.
    - Pavement segments of OGFC before performing any OGFC smoothness correction. The contractor must profile the sections and provide the engineer the result labeled as "PAVEO" inertial profiler data file.
    - Pavement segments of OGFC after performing any OGFC smoothness corrective work. The contractor must provide the engineer the result labeled as "FINALO" inertial profiler data file. If no corrective work in the segment is

performed, the contractor must use the "PAVEO" inertial profiler data file as the "FINALO" inertial profiler data file.

- For **concrete pavement**, smoothness measurements must be taken by the contractor during the following scenarios:
    - For new concrete pavement, measure profile:
        - After placing concrete, but before performing any smoothness corrections to calculate pavement MRI. The contractor must provide the engineer the results labeled as "PAVE" inertial profiler data file.
        - After performing any smoothness correction to calculate final MRI. The contractor must provide the engineer the results labeled as "FINAL" inertial profiler data file. If there is no corrective work in the segment, the contractor will use the "PAVE" inertial profiler data as the "FINAL" inertial profiler data.
    - For grinding existing pavement project type, measure profile:
        - Before any work is performed to calculate existing MRI. The contractor must provide the engineer the result labeled as the "EXIST" inertial profiler data file and notify the engineer if the MRI results vary by more than 10 percent from the MRI information provided by Caltrans at the time of advertisement.
        - After any work is performed but before grinding to calculate baseline MRI. This profile is required for informational purposes only. The contractor must provide the engineer the result labeled as "BASELINE" inertial profiler data file.
        - After the contractor's grinding achieves 60 MRI or 40 percent improvement, calculate final MRI. The contractor must provide the engineer the results labeled as "FINAL" inertial profiler data file.
- Verify that the inertial profiler displays a current certification. Both the left and right accelerometers must have a Caltrans-issued decal indicating the date the certification expires.
    - The inertial profiler must display a current certification decal showing the expiration date.
    - The certifications issued by Caltrans for the inertial profiler and operator must not be expired.
- Confirm the inertial profiler operator has a current Caltrans-issued certificate for each model of inertial profiler operated. Verify that the certificate covers the model of the certified inertial profiler. Find a current list of inertial profilers and operators at:

  https://dot.ca.gov/programs/engineering-services/inertial-profiler-certification-program
- Make sure the contractor marks the beginning and ending stations on the pavement shoulder. When stationing is covered by additional surfacing, pavement, or removed by cold planing, make sure markings are transferred to the next surface and display the same stationing. Before running verification tests, check that the beginning and ending stations are still clearly marked and that Caltrans' inertial profiler operator uses the same stationing as the contractor.

At locations requiring pavement smoothness testing using an inertial profiler:

- The engineer must witness inertial profiler calibration and verification tests including contractor inertial profile smoothness measurements.
- The contractor must notify the engineer at least 2 business days before performing calibration and verification testing of the inertial profiler.
    - Before each day of profiling and in the presence of the engineer:
        - The contractor must conduct all of the following calibration and verification tests:
            1. Block test to verify the accuracy of the height sensor using California Test 387, “Method of Test for Operation, Calibration and Operator Certification of Inertial Profilers.”
            2. Bounce test to verify the combined accuracy of the height sensor and accelerometer using California Test 387.
            3. Distance measurement instrument (DMI) test to verify the accuracy of the distance measuring instrument using California Test 387.
            4. Manufacturer's recommended tests.
            5. For further information on performing these verifications tests, see Appendix J, “Performing Verification Tests on Inertial Profilers,” of this manual.
        - At least annually, the contractor must conduct a cross-correlation verification.
- Caltrans inertial profile operators performing verification testing must also perform the block, bounce, and DMI test daily. The Caltrans inertial profiler operator must use the same 528-foot test section the contractor used to perform their daily DMI test.

At locations not requiring pavement smoothness testing using an inertial profiler:

- Make sure the contractor tests areas for smoothness using a 12-foot straightedge. After testing, check that the contractor submits a list of areas that require correction. Verify that each area is identified by size and location as required by the *Standard Specifications*.
- Confirm that a follow-up acceptance testing with a straightedge is performed to make sure the contractor’s list is complete. If the area was measured using an inertial profiler, consider using the ProVAL Rolling Straightedge module to help identify locations that should be manually checked with the straightedge.
- Verify that the contractor submits pavement smoothness data in compliance with the current pavement smoothness requirements.

After the Work (Measuring Pavement Smoothness)

- Contractors must submit an electronic copy of the raw profile data as a PPF file on an authorized data storage device within 12 hours or on the same day of completing smoothness measurements. The PPF file must be submitted with either a coordinated video or photographs taken at intervals no greater than 52.8 feet for the EXIST and

BASELINE profiles. Contractors are also required to submit a printout or a PDF file listing the following:

  - Profile data collection time and date
  - Data collection software version used
  - Sensor serial number
  - Low- and high-pass filter used
  - 0.1-MRI values

- After a contractor submits the profile information to Caltrans' file sharing system, the contactor must also send a notification of their electronic submittal to the engineer and to either Asphalt.Smoothness@dot.ca.gov or Concrete.Smoothness@dot.ca.gov with the names of the files submitted.
- For each surface subject to inertial profile smoothness requirements, the profile data information must include:
  1. Raw profile data for each lane (PPF files).
  2. ProVAL ride quality analysis report for the MRI of each lane in a PDF file. Report the following, using the ProVAL Ride Quality Fixed Interval MRI Report:
     a. Listing of MRI values for 0.1-mile segments or portions thereof.
     b. Input data including the specified MRI threshold and fixed segment length. The MRI threshold value shown in the report must correspond to the value that requires mandatory corrective action. The percent improvement MRI thresholds will vary, and these do not need to be shown in the report.
     c. Raw profile data name selections.
     d. Areas exempt from inertial profile smoothness requirements.
  3. ProVAL ride quality analysis report for the IRI of the left and right wheel paths of each lane in a PDF file. Report the following using the ProVAL Ride Quality Continuous IRI Report:
     a. Listing of areas of localized roughness (ALR)
     b. Input data including the specified ALR threshold and continuous segment length
     c. Raw profile data name selections
     d. Areas exempt from inertial profile smoothness
  4. GPS data file for each lane. Submit the data file in GPS exchange file format, which has a suffix of *.GPX.
  5. Manufacturer's recommended calibration and verification test results for the inertial profiler.
  6. Inertial profiler's calibration and verification test results, including results for bounce, block, and the distance measurement instrument.
  7. Completed Pavement Smoothness Inertial Profiler Submittal Record.

- Require the contractor to submit the raw profile data in an unfiltered pavement profile standard (PPF) file format. Reject any files that do not use the following file naming convention:

  YYYYMMDD_TTCCCRRR_EA_D_L_W_B_E_X_PT.EXT

  Where:

  YYYY = year

  MM = month, leading zero

  DD = day of the month, leading zero

  TT = district, leading zero

  CCC = county, 2- or 3-letter abbreviation

  RRR = route number with no leading zeros

  EA = contract number, excluding the district identification number, expressed as 6 characters

  D = traffic direction, NB, SB, WB, or EB

  L = lane number from left to right in the direction of travel

  W = wheel path, L for left, R for right, or B for both

  B = beginning station to the nearest foot, such as 10+20, or beginning postmile to the nearest hundredth, such as 25.06 with no leading zero

  E = end station to the nearest foot, such as 14+20, or ending postmile to the nearest hundredth, such as 28.06 with no leading zero

  X = profile operation, EXIST for existing pavement, BASELINE for existing pavement after performing repairs, PAVE for after paving, and FINAL for completed pavement documentation of compliance

  PT = type of pavement surface profiled, such as:

  Type A HMA (Hot Mix Asphalt)

  RHMA-G (Rubberized Hot Mix Asphalt-Gap Graded)

  OGFC (Open Graded Friction Course)

  JPCP (Jointed Plain Concrete Pavement)

  CRCP (Continuously Reinforced Concrete Pavement)

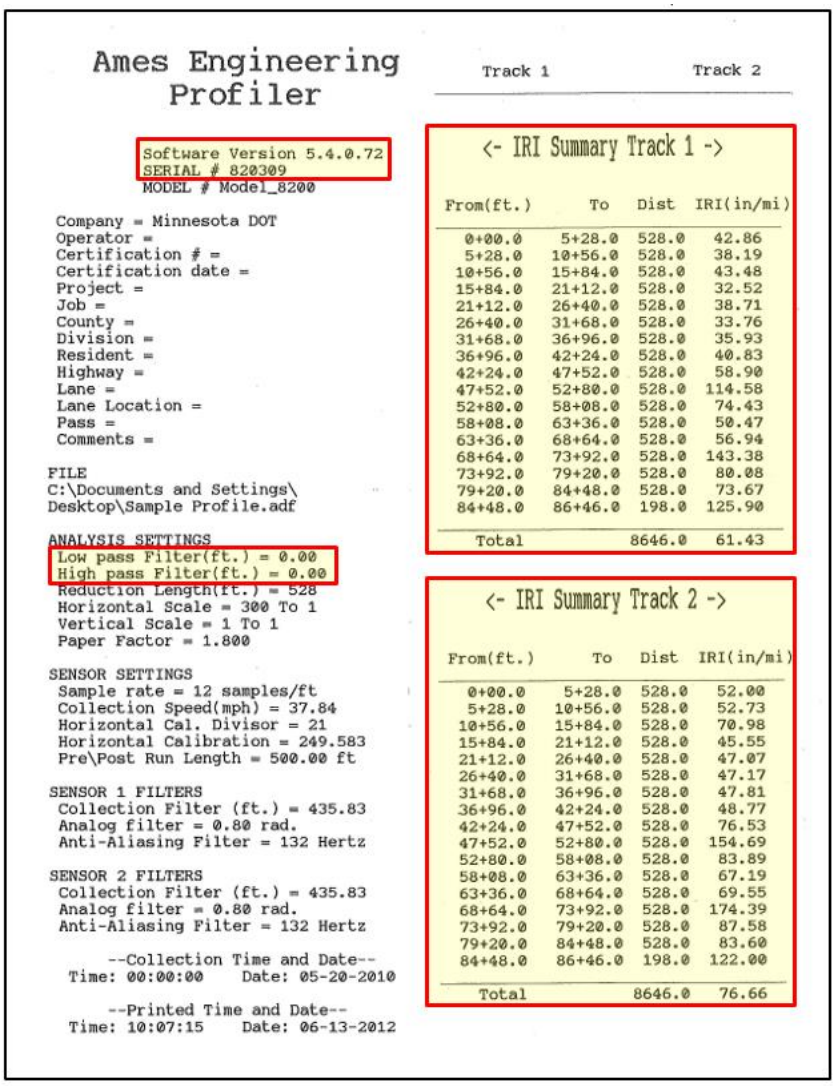
  EXT = “PPF” for raw profile data file extension

- Multiple inertial profiler data files should be compressed into a .ZIP file format and submitted using the file-naming convention TT_EA_X_YYYYMMDD.zip.
- The contractor must submit a smoothness corrective grinding plan as an informational submittal at least 2 business days before performing corrective grinding for areas that do not meet the smoothness requirements.
  - Review the smoothness corrective grinding plan to verify that only necessary grinding is being performed. The contractor will not be compensated for grinding into incentive pay for asphalt concrete. The payment adjustment worksheet accounts for this automatically by analyzing the adjustments due

on the PAVE uncorrected surface and the FINAL corrected surface. A contractor should only be developing grinds to address ALR and to reduce disincentives because of excessive MRI values. Grinding concrete pavement to receive incentive pay is allowed as long as the pavement meets the required thickness.

- The corrective grinding plan must include:
    1. Grinder make and model:
        a. Grinder wheelbase in feet, measured from the front centerline to the back centerline of the single wheel or tandem wheel spread
        b. Grinder head position in feet, measured relative to the centerline of the front single wheel or the front tandem wheel spread
    2. Tandem wheel spreads in feet
    3. Tabular listing of the planned corrective grinding, including:
        a. Start and end locations in stationing to the nearest foot
        b. Width of grind, such as left half lane, right half lane, or full-width lane
        c. Corresponding grinder head depths to the nearest 0.01 inch
        d. Direction of grind such as forward, reverse, forward-forward, reverse-reverse, forward-reverse, or reverse-forward
    4. Anticipated improvement in the MRI and ALR values.
- After each inertial profiling by the contractor, verify that the inertial profiles and other required files for contract compliance include, but are not limited to, the following:
    - PPF files and PDF report that are submitted on an electronic storage device and received within 12 hours or on the same day of completing the smoothness measurement.
    - Submittals for EXIST and BASELINE profiles include a coordinated video or photographs taken at a minimum of 52.8 feet.
    - File naming convention meets the specification requirement.
    - Stationing conforms with smoothness quality control plan.
    - Each PPF file is required to have a printout or PDF produced by the inertial profiler (not ProVAL). See Figure 4-1, “Sample of Printout to Receive on Each Day of Profiling,” for a sample of this report. Check the following:
        1. Profile data collection time and date matches the date the engineer witnessed the profile.
        2. Data collection software version used matches that used during inertial profiler certification.
        3. Sensor serial numbers on the inertial profilers match those used during inertial profiler certification.
        4. Low- and high-pass filters are set to zero. If they are not, request a new printout. Low- and high-pass filters smooth out the profile, which can result in lower smoothness values and higher pay adjustments.

5. 0.1-MRI values are listed. These MRI values are calculated by the profilers' software, not by ProVAL. The average of these numbers will be similar to the smoothness values entered into the profile summary worksheets submitted at a later date as part of the smoothness payment adjustment request submitted by the contractor.



Ames Engineering Profiler

Software Version 5.4.0.72
SERIAL # 820309
MODEL # Model_8200

Company = Minnesota DOT
Operator =
Certification # =
Certification date =
Project =
Job =
County =
Division =
Resident =
Highway =
Lane =
Lane Location =
Pass =
Comments =

FILE
C:\Documents and Settings\
Desktop\Sample Profile.adf

ANALYSIS SETTINGS
Low pass Filter(ft.) = 0.00
High pass Filter(ft.) = 0.00
Reduction Length(ft.) = 528
Horizontal Scale = 300 To 1
Vertical Scale = 1 To 1
Paper Factor = 1.800

SENSOR SETTINGS
Sample rate = 12 samples/ft
Collection Speed(mph) = 37.84
Horizontal Cal. Divisor = 21
Horizontal Calibration = 249.583
Pre\Post Run Length = 500.00 ft

SENSOR 1 FILTERS
Collection Filter (ft.) = 435.83
Analog filter = 0.80 rad.
Anti-Aliasing Filter = 132 Hertz

SENSOR 2 FILTERS
Collection Filter (ft.) = 435.83
Analog filter = 0.80 rad.
Anti-Aliasing Filter = 132 Hertz

--Collection Time and Date--
Time: 00:00:00 Date: 05-20-2010

--Printed Time and Date--
Time: 10:07:15 Date: 06-13-2012

Track 1 Track 2

<- IRI Summary Track 1 ->

From(ft.)	To	Dist	IRI(in/mi)
0+00.0	5+28.0	528.0	42.86
5+28.0	10+56.0	528.0	38.19
10+56.0	15+84.0	528.0	43.48
15+84.0	21+12.0	528.0	32.52
21+12.0	26+40.0	528.0	38.71
26+40.0	31+68.0	528.0	33.76
31+68.0	36+96.0	528.0	35.93
36+96.0	42+24.0	528.0	40.83
42+24.0	47+52.0	528.0	58.90
47+52.0	52+80.0	528.0	114.58
52+80.0	58+08.0	528.0	74.43
58+08.0	63+36.0	528.0	50.47
63+36.0	68+64.0	528.0	56.94
68+64.0	73+92.0	528.0	143.38
73+92.0	79+20.0	528.0	80.08
79+20.0	84+48.0	528.0	73.67
84+48.0	86+46.0	198.0	125.90
Total		8646.0	61.43

<- IRI Summary Track 2 ->

From(ft.)	To	Dist	IRI(in/mi)
0+00.0	5+28.0	528.0	52.00
5+28.0	10+56.0	528.0	52.73
10+56.0	15+84.0	528.0	70.98
15+84.0	21+12.0	528.0	45.55
21+12.0	26+40.0	528.0	47.07
26+40.0	31+68.0	528.0	47.17
31+68.0	36+96.0	528.0	47.81
36+96.0	42+24.0	528.0	48.77
42+24.0	47+52.0	528.0	76.53
47+52.0	52+80.0	528.0	154.69
52+80.0	58+08.0	528.0	83.89
58+08.0	63+36.0	528.0	67.19
63+36.0	68+64.0	528.0	69.55
68+64.0	73+92.0	528.0	174.39
73+92.0	79+20.0	528.0	87.58
79+20.0	84+48.0	528.0	83.60
84+48.0	86+46.0	198.0	122.00
Total		8646.0	76.66

Figure 4-1: Sample of Printout to Receive on Each Day of Profiling

- Upon receipt of the contractor's inertial profiles proposed for acceptance, review the FINAL profile data file and the two ride-quality reports. Carefully review the submittals to confirm:
    - All listed leave-outs meet the requirements for the contract.
    - The ride-quality analysis report for IRI indicates no locations where short continuous roughness exceeds the established specification limit for ALR.
- On the ride-quality analysis report for MRI, where 0.05-mile to 0.10-mile fixed increments are indicated, all MRI values must not exceed the maximum MRI provided for the

contract. Partial fixed increments 0.00- to 0.05-miles in length are not required to meet an MRI threshold, but are required to meet ALR threshold.

- After reviewing and accepting the contractor's profiles proposed for acceptance, request that Caltrans' inertial profile be run. Include a copy of the contractor's raw data file. Before submitting the request, confirm that the contractor's semi-permanent reference points for the beginning and ending stationing locations are still clearly visible as described in the smoothness quality control plan. Caltrans must use the same stationing and semi-permanent reference points for verification profiles. This allows both files to be simultaneously loaded in ProVAL and compared for differences.
- Upon receipt of Caltrans' verification inertial profile runs, evaluate, and verify the contractor's profiles, as described in the next section.

Profile Verification

- The resident engineer must verify a minimum 10 percent of profiles used to determine payment adjustment.
- Verification testing will be performed using Caltrans' inertial profiler. The engineer must notify the contractor of Caltrans' intention to perform verification testing:
    - Acceptance test results will be used for incentive or disincentive payments if the contractor's overall MRI is within 10 percent of Caltrans' overall MRI from the same project length.
    - If the acceptance test results are not considered acceptable, Caltrans' MRI values will be used in the calculation for incentive and disincentive payments for that evaluated length. Caltrans will have 15 days to complete an evaluation of both profiler certifications.
- The contractor and the engineer must work together to avoid conflicts and to resolve disputes regarding test result discrepancies in accordance with Section 36-3.01D(4)(b), "Profile Verification," of the *Standard Specifications*.
- Contractors must notify the engineer within 5 business days of receiving the verification test result if they intend to dispute it:
    - An independent third party will perform referee testing over the same project length. Before the third party participates in a dispute resolution, their profiler and operator must be certified under Caltrans' "Profiler Certification Program." The independent third party must have no previous direct involvement with this contract and no current direct involvement with the contractor. The mean MRI value closest to the independent third party's mean MRI value will be used to calculate incentive and disincentive payment. The party with the MRI value furthest from that of the independent third party's will pay for the referee testing.
- Areas requiring pavement smoothness determined using a 12-foot straightedge must not vary from the lower edge of the straightedge by more than:
    - 0.01 foot when the straightedge is laid parallel with the traffic lane centerline.
    - 0.02 foot when the straightedge is laid perpendicular to the centerline and extends from edge to edge of a traffic lane.
    - 0.02 foot when the straightedge is laid within 24 feet of a pavement conform.

- The specifications require a physical check with a 12-foot straightedge to determine if the surface meets specification. The ProVAL software has a "rolling straightedge" module to assist with determining compliance and identify where to physically check locations with a 12-foot straightedge.

Payment

- The contractor must submit a payment adjustment spreadsheet with their data:
  - The contractor may obtain the spreadsheet from the following site:

    https://dot.ca.gov/programs/construction/pavement-smoothness
- The engineer uses this spreadsheet for payment purposes only after taking all of the following steps to verify that:
  1. No MRI values are in the "must correct" range.
  2. The contractor certified that all ALR issues have been resolved
  3. The contractor's profiles used in the payment adjustment spreadsheet are aligned within tolerance.
  4. The contractor's MRI data is directly from ProVAL.
  5. Caltrans' verification profiles are within 10 percent of the contractor profiles.
  6. The profiles used in the PVP are from the same PPF files received the day the profiles were run.

     The front worksheet in the spreadsheet titled "PayAdj" will highlight locations that do not meet the previous requirements. If you see red on this worksheet, immediately reject the payment adjustment spreadsheet with a description of the issues.

  For instructions on using the payment adjustment spreadsheet, see Appendix F, "Pay Adjustment Example."

  After successfully verifying the payment adjustment spreadsheet data using the steps listed, make the applicable payment adjustment using the internet Extra Work Bills system with a change order that encumbers the supplemental fund allotment for the smoothness adjustment incentives.

Determining Pay Adjustment for Asphalt Concrete

The contract specifications require the use of the payment adjustment spreadsheet to determine the applicable payment adjustment for HMA pavements.

Selecting the "layer thickness" and the "HMA Type" on the front worksheet determines which of the payment adjustment tables will be used. Appendix F shows an example. Table 4-2, "Pay Adjustment Applicable Sections in the *Standard Specifications*," shows where to find adjustments to use. The determination of when to use the Percent Improvement Pay Adjustment Tables is determined after evaluating which of the EXIST or BASELINE MRI values will be used for the MRI_0 value.

Table 4-2 - Pay Adjustment Applicable Sections in the *Standard Specifications*

Pay Adjustment for HMA Pavement	Applicable Section in the *Standard Specifications*
Pay Adjustments for Pavement Constructed on Existing Pavement Surfaces (Pay range of target MRI Pay Adjustment)	39-2.01A(4)(i)(iii)(C)

Pay Adjustments for New Pavement Alignment or Pavement Realignment

For new HMA pavement alignment or HMA pavement realignment, pavement smoothness pay adjustments are based on the contractor's verified inertial profiler data. Table 4-3, "Pay Adjustment for New Pavement Alignment or Pavement Realignment," shows payment ranges.

Table 4-3 — Pay Adjustment for New Pavement Alignment or Pavement Realignment

MRI_{SEG} (in/mi)	Pay Adjustment per 0.1 Mile per Lane ≥ 0.3 feet (See Note 1)	Pay Adjustment per 0.1 Mile per Lane <0.3 feet (See Note 1)	Corrective Action (See Note)
≤ 40.00	+ $900.00	+ $450.00	None
40.01 - 50.00	+ [(50.00 - MRI_{SEG}) x $90.00]	+ [(50.00 - MRI_{SEG}) x $90.00]	None
50.01 - 60.00	Full Pay	Full Pay	None
60.01 - 80.00	- [(MRI_{SEG} - 60.00) x $142.5.00]	- [(MRI_{SEG} - 60.00) x $101.25]	Optional
> 80.00	Not Applicable	Not Applicable	Mandatory

Note: See Section 39-2.01A(4)(i)(iii), "Pavement Smoothness," of the *Standard Specifications.*

Note 1: Total HMA thickness exclusive of OGFC and HMA leveling course and structural section repairs

No ALR exceeding values of 160 IRI are allowed.

Corrective Actions:

- Diamond grinding or remove and replace at the contractor's option.
- In accordance with Section 39-2.01C(16), "Smoothness Corrections," of the *Standard Specifications*.

- When OGFC is being placed over HMA, these requirements apply to the HMA surface that the OGFC is being placed on. Smoothness requirements for OGFC are specified in Section 39-2.04A(4)(c)(iii), “Pavement Smoothness of OGFC,” of the *Standard Specifications*.

Pay Adjustments for Pavement Constructed on Existing Pavement Surfaces (Pay Range of Target MRI)

When pay range pay tables are used, pavement smoothness pay adjustments are based on the contractor’s verified inertial profiler data. Determine payment adjustments using a pay range of target MRI (MRI_T). The target MRI is determined by the “EXIST” or "BASELINE" MRI (MRI_0) exclusive of the OGFC and the number of opportunities as shown in Table 4-4: “Target MRI (MRI_T)”

Table 4-4 — Target MRI (MRI_T)

Number of Opportunities	Target MRI (MRI_T)
1	= 0.2 x MRI_0 + 45
2	= 0.1 x MRI_0 + 50
3	= 55

Note: If the calculated MRI_T is less than 55, use MRI_T = 55

Opportunities for improving smoothness include:

- A single lift of asphalt, in which an HMA layer thickness allows the layer to be placed in more than one lift, the number of opportunities will be equal to the maximum number of lifts the layer can be broken into.
- Micro milling or cold planing not in the same shift as the paving. When you choose to micro mill or cold plane and pave in the same shift but have the option to micro mill or cold plane and pave in different shifts, the micro milling or cold planing will still be considered a separate opportunity.
- Segment correction.

Determine the target MRI (MRI_T) based on the number of opportunities and target MRI equations in Table 4-4.

MRI_{SEG} = the MRI of each 0.1-mile section of completed lane after all corrections.

Payment adjustments for each 0.1-mile segment of lane will be made as shown in Table 4-5, “Pay Adjustment for Pavement Constructed on Existing Pavement Surfaces.”

Table 4-5 – Pay Adjustment for Pavement Constructed on Existing Pavement Surfaces

Pay Ranges (See Note 2)	Payment Adjustment per 0.1 mi per Lane ≥ 0.3 foot (See Note 1)	Payment Adjustment per 0.1 mi per Lane < 0.3 foot (See Note 1)	Corrective Grinding in Fixed Increment (See Note)
$MRI_{SEG} \leq MRI_T$-20	$900.00	$450.00	May only grind areas to meet localized roughness thresholds
MRI_T -20 < MRI_{SEG} < MRI_T - 5	+ [(MRI_T - 5) – MRI_{SEG}] x $60.00	+ [(MRI_T - 5) - MRI_{SEG}] x $30.00	May only grind areas to meet localized roughness thresholds
MRI_T - 5 < $MRI_{SEG} \leq MRI_T$ + 5	Full Pay	Full Pay	May only grind areas to meet localized roughness thresholds
MRI_T + 5 < MRI_{SEG} ≤ greater of 90 or (MRI_T + 20)	- [MRI_{SEG} - (MRI_T + 5)] x $190.00, deduction not to exceed $2,850	- [MRI_{SEG} - (MRI_T + 5)] x $90.00, deduction not to exceed $1,350	Corrective grinding permitted
MRI_{SEG} > greater of 90 or (MRI_T + 20)	Not Applicable	Not Applicable	Mandatory Correction

Note: 39-2.01A(4)(i)(iii), "Pavement Smoothness," of the *Standard Specifications*.

Note 1: Total HMA thickness exclusive of OGFC and HMA leveling courses and structural section repairs.

Note 2: MRI_{SEG} = the MRI of each 0.1-mile section of completed lane after all corrections.

No ALR greater than ALR_{MAX} are allowed. ALR_{MAX} is the greater value of 160 in/mi or calculated value using the following equation:

$ALR_{MAX} = 2.1 \times MRI_T$

Determining Pay Adjustment for Concrete Pavement

- Pavement smoothness is measured in accordance with Section 36-3, "Pavement Smoothness," of the *Standard Specifications*. The following tables show the pavement and project types along with the applicable smoothness. A partial section greater than

one half of a 0.1-mile segment will receive proportional pay adjustment. Partial segments less than one half of 0.1-mile segment are not adjusted, but still require localized roughness to not exceed the threshold of 160 inches per mile.

Table 4-6 — Concrete Smoothness Selection

Pavement Type	Project Type	Smoothness Table
CRCP (See Note 1)	New Alignment	Target 60
CRCP	Widening or Lane Replacement	Target 67.5
JPCP (See Note 2)	New Alignment	Target 67.5
JPCP	Widening or Lane Replacement	Target 75
CRCP/JPCP	Grinding Existing Concrete Pavement	Percent Improvement

Note 1: Continuously Reinforced Concrete Pavement

Note 2: Jointed Plain Concrete Pavement

Table 4-7 — Target 60 Smoothness

0.1-mi MRI (in/mi)	Pay Adjustment/0.1 mi	Corrective Action (See Note 1)
≤ 45.00	+ $1,500	None
45.01 - 55.00	+ [(55 - MRI) x $150]	None
55.01 - 65.00	0	None
65.01 - 80.00	- [(MRI - 65) x $150]	Optional (See Note 2)
> 80.00	N/A	Mandatory (See Note 3)

Note 1: Corrective action must not reduce pavement thickness below minimums in Section 40-1.01D(8)(c)(iv), “Thickness,” of the *Standard Specifications*. Applicable to MRI only.

Note 2: Diamond grinding allowed.

Note 3: Correction is diamond grinding.

Table 4-8 — Target 67.5 Smoothness

0.1-mi MRI (in/mi)	Pay Adjustment/0.1 mi	Corrective Action (See Note 1)
≤ 50.00	+ $1,500	None
50.01 - 60.00	+ [(60 - MRI) x $150]	None
60.01 - 75.00	0	None
75.01 - 90.00	- [(MRI - 75) x $150]	Optional (See Note 2)
> 90.00	N/A	Mandatory (See Note 3)

Note 1: Corrective action must not reduce pavement thickness below minimums in Section 40-1.01D(8)(c)(iv), "Thickness," of the *Standard Specifications*. Applicable to MRI only.

Note 2: Diamond grinding allowed.

Note 3: Correction is diamond grinding.

Table 4-9 — Target 75 Smoothness

0.1-mi MRI (in/mi)	Pay Adjustment/0.1 mi	Corrective Action (See Note 1)
≤ 50.00	+ $1,500	None
50.01 - 60.00	+ [(60 - MRI) x $150]	None
60.01 - 90.00	0	None
> 90.00	N/A	Mandatory (See Note 2)

Note 1: Corrective action must not reduce pavement thickness below minimums in Section 40-1.01D(8)(c)(iv). Applicable to MRI only.

Note 2: Mandatory correction is diamond grinding.

- Caltrans does not pay for mandatory smoothness corrections. Corrective grinding is allowed to avoid or reduce negative pay adjustments. Grinding is also allowed to improve pay to positive pay adjustments as long as the pavement thickness is not reduced below required minimums.
- Pavement smoothness pay adjustments are applied in addition to other pay adjustments.
- Before any widening or lane replacement project using concrete begins, the adjacent existing concrete pavement lanes should be ground full-width.
- The corrective actions for grinding existing concrete pavement based on the final MRI are shown in Table 4-10, "Percent Improvement Smoothness."

Table 4-10 — Percent Improvement Smoothness

0.1-mi MRI_{EXIST} (in/mi) (See Note 1)	0.1-mi MRI_{FINAL} (in/mi) (See Note 2)	Corrective Action
≤ 100	≤ 60	None
≤ 100	>60	Mandatory **(See Note 3)**
> 100	≤ 0.6 x MRI_{EXIST}	None
> 100	> 0.6 x MRI_{EXIST}	Mandatory **(See Note 3)**

Note 1: Existing MRI

Note 2: Final MRI

Note 3: Mandatory correction is another pass of diamond grinding.

- Once final corrections are completed, the contractor must submit an electronic ProVAL project (PVP) file for each lane using the same naming convention listed in Section 36-3.01C(2), “Inertial Profiler Data,” of the *Standard Specifications*, except:

  B = use the common beginning station found in all profiles included in the PVP file followed by the postmile to the nearest tenth of a mile, such as 528 +00(10.0).

  E = use the ending station found in the FINAL profile followed by the postmile to the nearest tenth of a mile such as 681+12(12.9).

  X = PayAdj.

  EXT = “PVP” for ProVAL project file extension.

  The contractor must use a single PVP file for each lane. Each PVP file must contain the PPF files from the profile operation shown in Table 4-1, “Profiles Needed by Smoothness.”

Chapter 5: Third Party Dispute Resolution Process

As part of verification process, the resident engineer will perform verification testing on a minimum of 10 percent of the contractor's inertial profile runs. The contractor's acceptance test results will be accepted and used for incentive and disincentive payments if their mean MRI is within 10 percent of Caltrans' mean MRI verification testing for the same project length. Mean MRI is referred to in ProVAL as Overall MRI. For the contractor's test results that are not within 10 percent of mean MRI of the verification testing performed by Caltrans, the resident engineer must notify the contractor and attempt to resolve the differences. The contractor can ask the engineer to follow the dispute process outlined in this chapter. Note that the specification provides the option to the resident engineer, if both parties cannot come to agreement, to use Caltrans' MRI values instead of the test results provided by the contractor if the contractor's are not within 10 percent of Caltrans' verification results. The contractor's remaining profile values that do not have a corresponding engineer verification profile or are within 10 percent of the mean MRI will be used to calculate the incentive and disincentive payments.

Section 36-3.01D(4)(a), "General," of the *Standard Specifications* lays out the dispute resolution process to follow if there is a difference between the contractor's mean MRI results and Caltrans'. Section 39-2.01A(4)(i)(iv), "Dispute Resolution," of the *Standard Specifications,* provides the guidance for HMA projects and the language to state who pays for the third-party verification. This also covers concrete pavement. Following are the steps to take when administering this specification.

If Caltrans' verification results are not within 10 percent of the contractor's mean MRI, the resident engineer is encouraged to meet with the contractor, review the data, and confirm that the selected project lengths, DMI stations, and the beginning and ending semi-permanent reference points are same. The resident engineer is encouraged to request assistance from the district's smoothness expert and Headquarters Construction. It is the goal of Caltrans to avoid conflicts and resolve disputes regarding test result discrepancies.

If, after reviewing internally at Caltrans and reviewing with the contractor, the discrepancies are confirmed, the resident engineer must send a notice to the contractor of the discrepancies and Caltrans' intent to use its MRI values to calculate the incentive and disincentive. The contractor must notify the resident engineer within 5 business days of an intent to dispute Caltrans' verification test result.

To resolve the dispute, an independent third party will perform referee testing over the same selected project length. Before assisting with the dispute resolution, the third party must provide to both parties:

1. Proof they are currently certified under Caltrans' "Profiler Certification Program."
2. Certification they have no involvement with the contract and are not currently working directly for the contractor on other projects.

It is recommended that both the contractor and resident engineer witness the referee testing by the independent third party. Once the referee results are complete, the mean MRI values of the contractor, Caltrans, and independent third party are compared. The MRI values used to

calculate the incentive and disincentive payments will be from the party whose mean MRI value is closest to the independent third party's mean MRI value. The other party will pay for the referee testing.

Appendixes

Appendix A: Inertial Profiler – Quick Reference

Definition

Inertial profilers are used to measure longitudinal wheel path surface elevation profiles of highways based on an inertial reference system that is mounted on a host vehicle.

Components

Inertial profilers typically consist of the following equipment:

- System Controller
- Accelerometer
- Laser
- Distance Measurement Instrument (DMI)

Requirements

Inertial profilers must be calibrated, and operators certified to measure profiles for acceptance and verification on projects. Certification is valid for one year for both equipment and operator from date of testing.

The following calibration and verification tests must be performed in the engineer's presence each day before profiling:

- Block
- Bounce
- DMI
- Manufacturer's recommended

Caltrans' inertial profiler used for verification must also perform the same tests each day before profiling.

Limitations

Section 36-3.01D(3)(b)(i) "General," of the *Standard Specifications* defines areas that are excluded from the MRI smoothness requirements, but are subject to evaluation for ALR and the 12-foot straightedge. It also defines areas that are excluded from smoothness testing with an inertial profiler, but are subject to evaluation with the 12-foot straightedge:

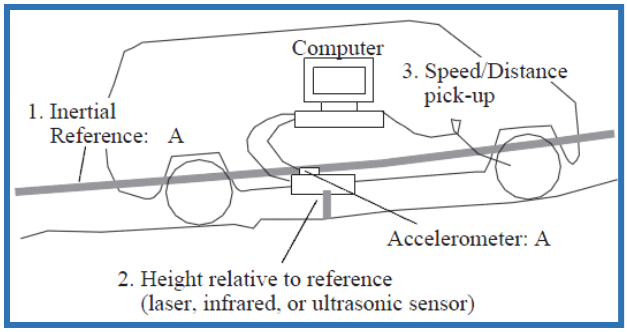


Figure A-1: Diagram of a vehicle's inertial profiling system

Data

Designers must request smoothness data during the project initiation document phase of the project.

Construction must request smoothness data to verify the contractor's results.

Availability

Table A-1 — Certified Inertial Profilers in California

Entity	Number of Inertial Profilers (as of January 2020)
Caltrans	14 each statewide: District 1 (1 SSI model CS9100) District 2 (1 SSI model CS9100) District 3 (1 SSI model CS9100) District 4 (1 AMES model 8200), District 5 (1 SSI model CS9100) District 6 (1 SSI model CS9100) District 7 (1 SSI model CS9100) District 8 (2 SSI model CS9100) District 9 (1 SSI model CS9100) District 10 (1 SSI model CS9100) District 11 (2 SSI model CS9100) District 12 (1 SSI model CS9100)
University of California	UCPRC (1 SSI model CS9100)
Contractors	44 statewide: 4 AMES model 8300 3 Dynatest model 5051 Mark IV

	4 SSI model CS8700 (Lightweight) 31 SSI model CS9100 2 SSI model CS9300

References

AASHTO R56, “Standard Practice for Certification of Inertial Profiling Systems”

AASHTO R57, “Standard Practice for Operating Inertial Profiling Systems”

AASHTO E2560, “Standard Specification for Data Format for Pavement Profile”

CTM 387, “Method of Test for Operation, Calibration and Operator Certifications of Inertial Profilers”

Caltrans Inertial Profiler Certification Program Website:

https://dot.ca.gov/programs/engineering-services/inertial-profiler-certification-program

Caltrans Smoothness Intranet Website (Division of Maintenance).

https://maintenance.onramp.dot.ca.gov/paveprogram/pavement-smoothness

Caltrans Smoothness Intranet Website (Division of Construction):

https://construction.onramp.dot.ca.gov/administrative-support/pavement-smoothness

Memo to the Deputy Directors, dated August 15, 2016, calling for Inertial Profiling. See Appendix H, “Providing Pavement Profile Smoothness Data.”

Appendix B: Automated Pavement Condition Survey

Definition

The Automated Pavement Condition Survey (APCS) is an annual survey of pavement condition of the State Highway System operated and maintained by Caltrans. The survey is performed by instruments in vehicles travelling at highway speeds.

Highlights

The following data from the most recent APCS cycle will be available:

- Asphalt concrete surface distress data
- Portland cement concrete surface distress data
- Longitudinal and transverse profile data
- Video images of roadway surface condition

Uses

APCS data is a tool for design engineers. Data from the most recent pavement survey can be used to generate a detailed report of surface distress and longitudinal profiles, which are critical inputs during the planning and design phases of a project.

Designers can extract IRI and MRI profile data of 0.1-mile segments for the proposed project limits. Existing roadway profiles coupled with a surface distress summary are critical to evaluate treatment options.

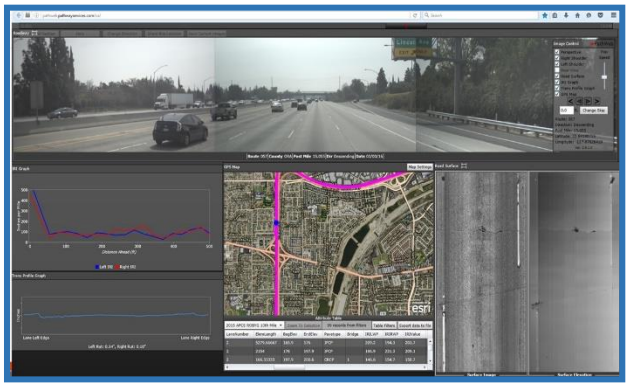


Figure B-1: Screen capture from Caltrans' Pavement Management System

Pavement Condition Report Tool

Pavement Condition Report (PCR) tool is at the Pave M (Pavement Management System) intranet site. Users can generate individual reports of current and expected pavement condition for the highway of interest. Thus, designers can optimize treatment selection based on the predicted pavement condition at the end of service period in years.

Availability

APCS and PCR tools can be accessed at the following link:

https://maintenance.onramp.dot.ca.gov/pavemgmtperf/pavem-portal

Support

Office of Pavement Management can provide assistance with pavement data.

Contact: Robert Hogan, Office Chief
Office: (916) 274-6063
Robert.Hogan@dot.ca.gov

Appendix C: ProVAL

Definition

ProVAL (Profile Viewing and Analysis) is an engineering software application developed for the Federal Highway Administration and the Long-Term Pavement Performance program. It is used to view and analyze pavement smoothness profiles.

Highlights

- View Wheel Path Profiles
- Analyze MRI
- Analyze ALR
- Simulate Grinding
- Predict Grinding Locations

Uses

This program analyzes wheel path profiles for smoothness determination.

Designers use this program to identify MRI of the segments and ALRs for determining prepave correction locations, if any.

Construction engineers will use this program to identify MRI of the segments and ALRs for determining smoothness specifications compliance. The program will also be used for verification purposes and for pay adjustment calculations.

Grinding Simulator

The Smoothness Assurance Module (SAM) of this program can predict grinding locations to reduce MRI and ALR. The grinding simulation can emulate a fixed frame diamond grinder with an 18-foot, 25-foot, or custom wheelbase. The grinding simulation cannot emulate any other equipment.

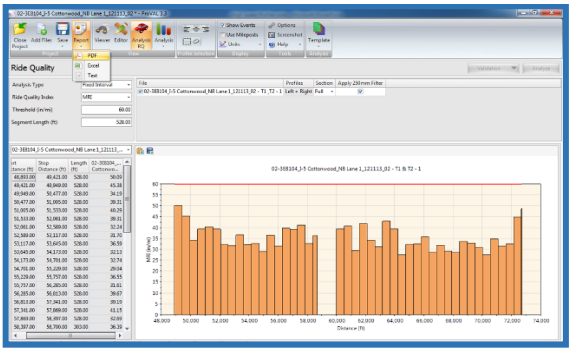


Figure C-1: Grinding simulation from the SAM

Input Data

The wheel path profile data is collected by an inertial profiler and is recorded in a PPF raw profile data filetype format. This native format provides an efficient means to analyze the data.

Availability

This program is freeware and is on Caltrans' Approved Software List. The software is hosted by FHWA and can be downloaded from:

http://www.roadprofile.com/

Support

Caltrans hosts tutorial videos for this program. Caltrans staff can find the videos at:

https://maintenance.onramp.dot.ca.gov/paveprogram/office-asphalt-pavements

In addition to these tutorials, Headquarters Division of Construction and the Division of Maintenance's Pavement Program will also provide training to Caltrans staff as requested.

Appendix D: Pathweb

Definition

Pathweb is a tool to view the video images of pavement recorded during the annual APCS data collection event.

Uses

Pathweb can be used by designers to review the pavement conditions found during the most recent data collection. Designers can use the review to determine a treatment strategy based on the distresses and ride quality of existing surfaces to deliver optimal results.

Availability

Pathweb is available at:

https://pathweb.pathwayservices.com/ca/

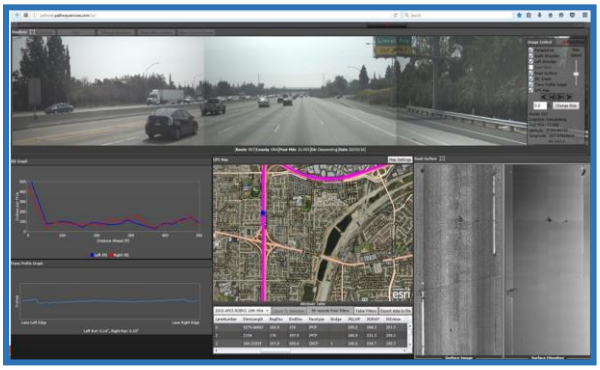


Figure D-1: Screen capture from Caltrans' Pavement Management System

Appendix E: Asphalt Smoothness Guidance & Examples for Construction Inspectors

Purpose

This asphalt concrete pavement smoothness guidance for construction inspectors was developed to help administer contracts with smoothness specifications. This guidance will help the inspector identify MRI pay adjustment for segments, compare smoothness data, identify any mandatory or optional correction requirements, and calculate pay adjustments. This appendix is for information only; use the payment adjustment spreadsheet to calculate payment incentive or disincentive in accordance with the contract.

Smoothness Profiles

The contractor will provide smoothness data to Caltrans at the following stages:

- Existing surface
- After prepave corrections
- After paving
- After corrections, if necessary

In accordance with the specifications, Caltrans may verify the smoothness data at each stage of the project, depending on schedule. Caltrans will use its own inertial profilers or contract with a smoothness consultant for quality-assurance verification. Caltrans and the contractor must use ProVAL to calculate the smoothness profile data. The smoothness profile data must not vary more than the tolerance identified in the specifications.

Determine MRI_0 Smoothness Profile

Both the paving thickness and the MRI_0 value will dictate pay adjustment for each 0.1-mile segment. MRI_0 is determined as the lower MRI value from the EXIST and BASELINE profile, except when the bid item “Segment Correction” is used, then MRI_0 is from the EXIST profile.

If there are no prepaving corrections proposed to the existing surface, or the existing surface is to be cold planed, the baseline profile will be the existing surface.

Pay Adjustments for HMA (Except OGFC)

The layer thickness and MRI_0 value will determine the pay adjustment tables to be used for each 0.1-mile MRI_{SEG}. The pay adjustment tables describe the 0.1-mile MRI_{SEG} ranges for the following:

- Full Pay — Expected MRI range
- Incentive — Exceed expected MRI range
- Disincentive — Did not meet expected MRI range

- Mandatory Correction – Exceeded maximum allowable MRI

Once the smoothness profile of the paved surface is collected, the resulting 0.1-mile MRI_{SEG} of the paved surface will be compared to the pay adjustment tables in the specifications. For each 0.1-mile MRI_{SEG} that falls within the incentive or disincentive range, the pay adjustment table will provide an equation for calculating the credit or deduction.

The magnitude of a 0.1-mile MRI_{SEG} in the disincentive range will determine whether a mandatory or optional correction will be required. In the case of a 0.1-mile MRI_{SEG} within the optional correction range, the contractor can either take a deduction or correct the paved surface to move out of the disincentive range. Corrections to the paved surface can only result in full pay or stay as a disincentive. Corrections cannot push the contractor into the incentive range.

In addition to the 0.1-mile MRI_{SEG} thresholds, there are ALR requirements that must be met. No ALR greater than ALR_{MAX} are allowed. ALR_{MAX} is the greater value of 160 in/mi or calculated value using the following equation:

$ALR_{MAX} = 2.1 \times MRI_T$

If the 0.1-mile MRI_{SEG} value has exceeded the expected MRI range into incentive territory, but the ALR is not met, then the contractor must correct the surface to reduce the ALR. The 0.1-mile MRI incentive payment will be based on the MRI values before ALR correction.

Pay Adjustments for OGFC

The pay adjustments for OGFC will follow the same process as HMA. However, the pay adjustment tables will differ based on percent of MRI_T, and corrective grinding is only allowed to address ALR.

For OGFC placed as part of new construction or over paving on the same project, incentives will not be allowed. Only a disincentive or full pay is allowed.

For OGFC placed on existing pavement or a milled surface, the pay adjustment table allows for incentive, full pay, and disincentive.

Pay Adjustment Spreadsheet

The profile data for each stage must be loaded onto Caltrans' smoothness data sheets by the contractor and provided to the resident engineer. The contractor must provide the data collected each day, on that day. The quality assurance of these sheets will be the responsibility of the resident engineer.

Example 1 – HMA Thickness < 0.30 -Foot Over Existing Surface

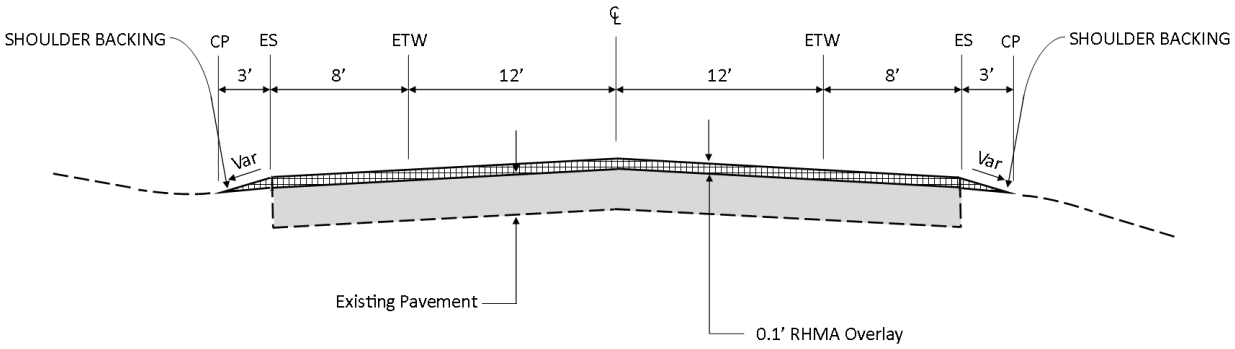


Figure E-1: Typical Cross Section

Project Information:

Roadway Facility: Two lane highway

Direction: NB-SB

Limits: Postmile 5 to 6

Stationing: 100+00 to 152+80

Total Lane Miles: 2 (1 in each lane)

HMA Thickness: 0.10-foot HMA Overlay

Scope: Pave over existing surface

Prepaving Corrections: NB Segments 1, 2, 3, and 4. SB Segments 7, 8, 9, and 10

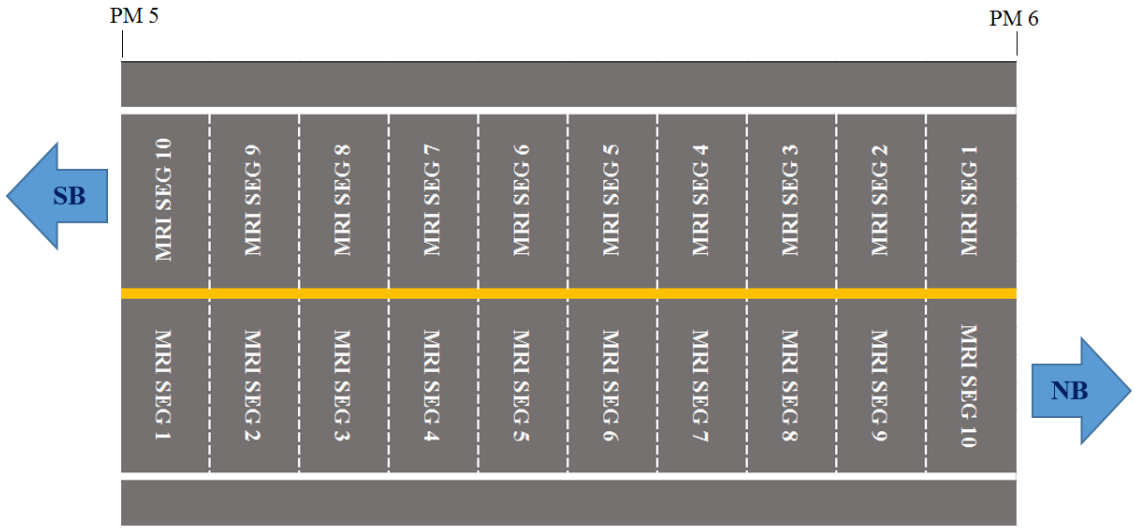


Figure E-2: Plan view of roadway segments

Layout

Existing MRI Segments:

Table E-1 — NB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
190	187	175	145	125	99	97	90	95	100

Table E-2 — SB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 6 to 5									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
98	95	100	102	96	131	143	160	154	151

MRI_{SEG} After Structural Section Repairs:

Table E-3 — NB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
150	162	149	130	125	99	97	90	95	100

Table E-4 — SB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 6 to 5									
SEG1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
98	95	100	102	96	131	140	112	133	147

39-2.01A(4)(i)(iii)(C) Pay Adjustments for Pavement Constructed on Existing Pavement Surfaces

Table E-5 — Target MRI

Number of opportunities	Target MRI (MRI_T) (See Note)
1	= 0.2 x MRI_0+45
2	= 0.1 x MRI_0+50
3 or more	= 55

Note: MRI_T based on 2 opportunity equations for segments NB: 1, 2, 3, 4 and SB: 7, 8, 9, 10.

MRI_T based on one opportunity equation for all the other segments

Table E-6 — NB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
69	68.7	67.5	64.5	70	64.8	64.4	63	64	65

Table E-7 — SB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 6 to 5									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
64.6	64	65	65.4	64.2	71.2	64.3	66	65.4	65.1

MRI_{SEG} After 0.10 Feet HMA Overlay:

Table E-8 — NB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
125	120	104	91	82	64	61	65	68	70

Table E-9 — SB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 6 to 5									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
59	58	60	60	62	89	90	62	83	101

Analysis:

Step 1: Determine the pay adjustment table for each MRI_{SEG}

Section 39-2.01A(4)(i)(iii), "Pavement Smoothness," of the *Standard Specifications*, outlines the criteria that determines which pay adjustment table is applied for each existing MRI_{SEG}. For MRI of the segments that undergo prepaving corrections, the criteria to determine the pay adjustment will apply to the after-prepaving corrected MRI. The criteria are as follows:

Table E-10 – Pay Adjustment for Pavement Constructed on Existing Pavement Surfaces

Pay Ranges (See Note 2)	Payment Adjustment per 0.1 mi per Lane ≥ 0.3 foot (See Note 1)	Payment Adjustment per 0.1 mi per Lane < 0.3 foot (See Note 1)	Corrective Grinding in Fixed Increment (See Note)
$MRI_{SEG} \leq MRI_T$-20	$900.00	$450.00	May only grind areas to meet localized roughness thresholds
MRI_T -20 < MRI_{SEG} < MRI_T -5	+ [(MRI_T - 5) - MRI_{SEG}] x $60.00	+ [(MRI_T - 5) - MRI_{SEG}] x $30.00	May only grind areas to meet localized roughness thresholds
MRI_T - 5 < $MRI_{SEG} \leq MRI_T$ + 5	Full Pay	Full Pay	May only grind areas to meet localized roughness thresholds
MRI_T + 5 < MRI_{SEG} ≤ greater of 90 or (MRI_T + 20)	- [MRI_{SEG} - (MRI_T + 5)] x $190.00, deduction not to exceed $2,850	- [MRI_{SEG} - (MRI_T + 5)] x $90.00, deduction not to exceed $1,350	Corrective grinding permitted
MRI_{SEG} > greater of 90 or (MRI_T + 20)	Not Applicable	Not Applicable	Mandatory Correction

Note 1: Total HMA thickness exclusive of OGFC and HMA leveling courses and structural section repairs.

Note 2: MRI_{SEG} = the MRI of each 0.1-mile section of completed lane after all corrections.

Based on the MRI_{SEG} data results from the inertial profile data collected after prepaving corrections and using the previously listed criteria, the following pay adjustment table will be applied to each MRI_{SEG}:

Table E-11 — Pay Adjustment Tables for NB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
MC	MC	MC	MC	DIS	FP	FP	FP	FP	FP

Table E-12 — Pay Adjustment Tables for SB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 6 to 5									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
INC	INC	FP	FP	FP	DIS	DIS	FP	DIS	MC

Notes:

INC = Incentive

FP = Full Pay

DIS = Disincentive

MC = Mandatory Correction

Step 2: Calculating Pay Adjustments

Determine the applicable pay adjustments and whether mandatory corrections are required for each MRI_{SEG} of the proposed final surface.

In this example, the smoothness profile data collected after prepaving corrections is considered the baseline. The smoothness profile data collected after the overlay is considered the paved surface.

Northbound

1. Identify the pay adjustment table to be used for each MRI_{SEG}:
    a. MRI segments 1 through 4 fall under the Mandatory Correction
    b. MRI segment 5 falls under Disincentive
    c. MRI segments 6 through 10 fall under full pay
2. Go to the pay adjustment for pavement constructed on existing pavement surfaces in the *Standard Specifications*:
    a. Determine the target MRI (MRI_T)

    The MRI_T equation is based on number of opportunities. In this example, there is a 0.1-foot HMA overlay on existing pavement, plus segment correction on segment 1. Thus, there are two opportunities. In accordance with *the Standard Specifications*, use the following equation:

MRI_T = 0.1 x MRI_0 + 50 or 55, whichever is greater

Note: MRI_0 is the lower MRI value from the EXIST and BASELINE profiles for the 0.1-mi segment, except MRI_0 is the MRI Existing of the segment when there is a segment correction.

Calculate the MRI_T for segment 1:

MRI_T = (0.1 x 190 inches per mile) + 50 inches per mile = 69 inches per mile, which is greater than 55

Similar calculations for segments 2 and 3 yield the following:

Table E-13 — MRI Values

NORTHBOUND			
	SEG 1	SEG 2	SEG 3
MRI_T (in/mi)	69	68.7	67.5

b. Use the MRI_{SEG} and MRI_T to determine the pay adjustment

Based on the calculated MRI_{SEG} and MRI_T, the *Standard Specifications* pay adjustment constructed on existing pavement table indicates that segments 1, 2, and 3 will require mandatory MRI correction by the contractor. Once the contractor completes the mandatory corrections, repeat the process by recalculating the MRI_T, and MRI_{SEG}. The final MRI_{SEG} outcomes can only result in full pay or remain as a disincentive.

c. Use 39-2.01A(4)(i)(iii)(C), "Pay Adjustments for Pavement Constructed on Existing Pavement Surfaces," of the *Standard Specifications* to determine the pay adjustment or corrective action for segments 4 through 10.

Compare the MRI_{SEG} and MRI_T values after the 0.1-foot HMA overlay to the pay adjustment table The table will dictate any pay adjustments along with whether any corrections are mandatory, optional, or not allowed. The following are the results when applied to segments 4 through 10:

Table E-14 — Pay Adjustment for Pavement Constructed on Existing Pavement Surfaces

SEG	MRI_T Value (in/mi)	MRI_{SEG} Value (in/mi)	Pay Adjustment	Corrective Action
4	64.5	91	NA	Mandatory
5	70	82	$630 disincentive	Optional
6	64.8	64	Full Pay	None

7	64.4	61	Full Pay	None
8	63	65	Full Pay	None
9	64	68	Full Pay	None
10	65	70	Full Pay	None

Note: MRI_{SEG} is the MRI of each 0.1-mile section of complete lane after proposed final paving

The results indicate that the MRI on segments 6 through 10 are within Caltrans MRI thresholds. Thus, no corrective action is allowed.

The MRI on segments 4 and 5 are not within acceptable values. Segment 4 must undergo a mandatory corrective action, such as grinding or replacement. For segment 5, the contractor has the choice to either take a penalty of $630 and avoid corrective action or perform a corrective action. If the contractor performs a corrective action for segment 5, the final outcomes can only result in full pay or remain as a disincentive.

3. Areas of Localized Roughness

   a. Determine the areas of localized roughness (ALR) for each segment

      In addition to meeting MRI requirements, there are ALR requirements.

      The ALR requirements are as follows:

Table E-15 — ALR Requirement in Accordance With HMA Pay Adjustment for Pavement Constructed on Existing Pavement Surfaces

Table	Requirement
Percent Improvement	$ALR_{MAX} = 2.1 \times MRI_T$ or ALR ≤ 160 in/mi, whichever is greater

All segments must have an ALR ≤ 160 inches per mile or ≤ ALR_{MAX}, whichever is greater.

For the northbound segment, using the MRI_T previously calculated, the following ALR_{MAX} can be determined:

Table E-16 — ALR_{MAX} Value

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
160	160	160	160	160	160	160	160	160	160

Table E-17 — ALR_{MAX} Values

NORTHBOUND			
	SEG 1	SEG 2	SEG 3
ALR_{MAX} (in/mi)	168	174	168

Because all the ALR_{MAX} is less than 160 inches per mile, the ALR for all these segments is 160 inches per mile.

Note that when correction of ALR is performed in positive pay adjustment segments, pay adjustments cannot be improved.

Southbound Direction can be calculated in a similar way.

Step 3: Pay Adjustment Spreadsheet

In accordance with Section 36-3.01C(6)(c), "Payment Adjustment Spreadsheet," of the *Standard Specifications,* the contractor will submit a pay adjustment spreadsheet to Caltrans. The spreadsheet template is available at the following link:

https://dot.ca.gov/programs/construction/pavement-smoothness

EXAMPLE 2 — HMA THICKNESS ≤ 0.30 FOOT, WITH OGFC OVERLAY

Let's assume that Example 1 will also be overlaid with OGFC.

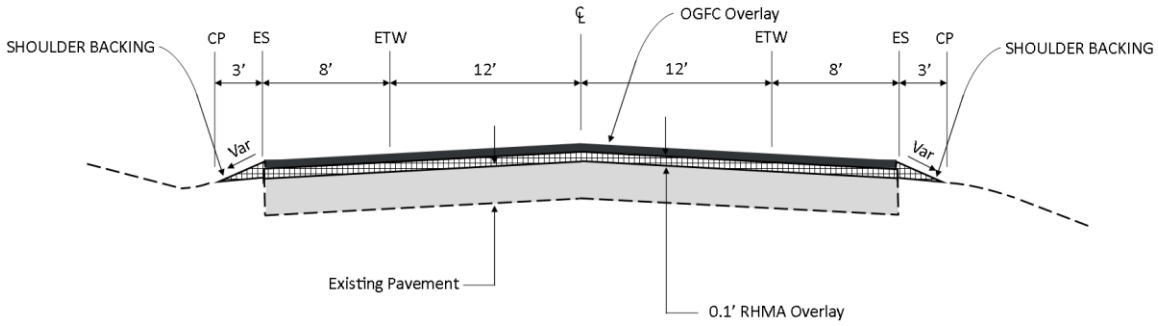


Figure E-3: Typical Cross Section

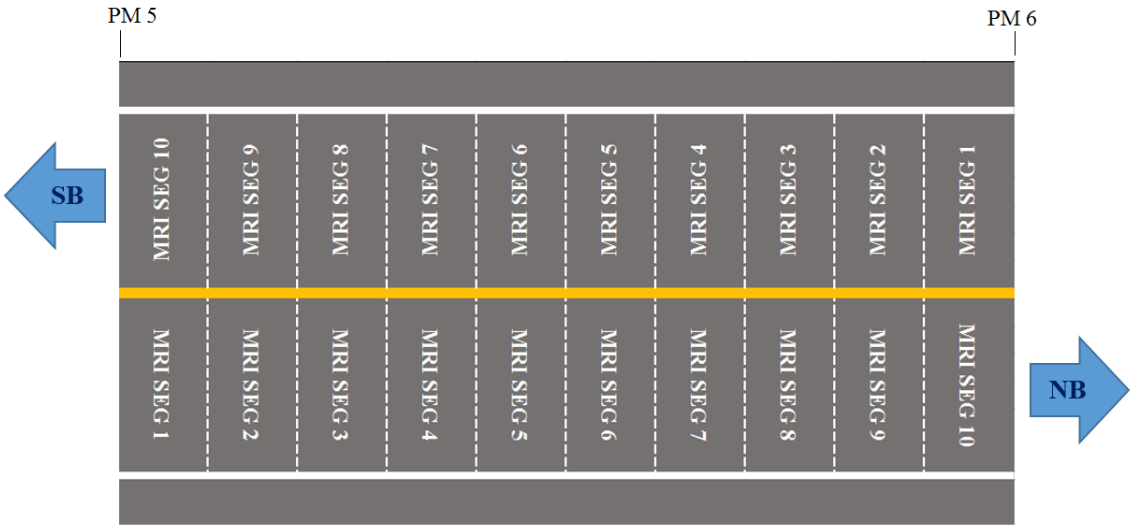


Figure E-4: Typical Layout

MRI_{SEG} after 0.10-foot RHMA Overlay and Corrections:

Table E-18 — NB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
85	84	80	79	82	64	61	65	68	70

Table E-19 — SB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 6 to 5									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
59	58	60	60	62	89	90	62	83	101

MRI_{SEGO} after 0.10-foot OGFC Overlay:

Table E-20 — NB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 5 to 6									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
90	92	74	70	75	60	60	62	63	61

Table E-21 — SB LANE

0.1 Mile MRI_{SEG} (in/mi) – Postmile 6 to 5									
SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
60	63	66	66	62	72	80	61	69	81

Table E-22 — Pay Adjustment for OGFC on New Construction or HMA Overlay

Percent of target (PoT)	Payment adjustment per 0.1 mi per lane	Corrective action
PoT ≤ 100% of MRI_{TO}	Full pay	May only grind to meet ALR thresholds
PoT > 100% of MRI_{TO}	- (PoT - 100.00) x $100.00	May only grind to meet ALR thresholds

Step 1: Calculating Pay Adjustments

Determine the applicable pay adjustments and what type of corrections are permitted for each MRI_{SEGO} of the proposed final OGFC surface.

In this example, the smoothness profile data collected after corrections are completed on the 0.1-foot HMA overlay is considered the baseline. The smoothness profile data collected after the OGFC is placed is considered the proposed final surface.

Northbound

1. Identify the applicable pay adjustment for each MRI_{SEGO} for OGFC:
    a. In this example, OGFC is placed over the RHMA overlay; therefore, locate the specific OGFC pay adjustment table that applies to this situation in the specifications.
    b. Determine the target MRI for OGFC (MRI_{TO}) and percent of target MRI for OGFC (PoT_{OGFC}).

The OGFC is paved on RHMA overlay; therefore, it falls under Section 39-2.04A(4)(c)(iii), "Pavement Smoothness of OGFC," of the *Standard Specifications*. The MRI_{TO} of each segment is equal to final MRI of the RHMA layer. The following equation will be used to determine the percent of target MRI (PoT):

PoT = (MRI_{SEGO} / MRI_{TO}) x 100 percent rounded to the nearest 0.1 percent

In which:

MRI_{SEGO} = MRI of each 0.1-mi segment from PAVEO profile for OGFC paving

MRI_{TO} = final MRI of HMA layer which OGFC is placed on ($MRI_{FINALHMA}$)

Calculate the PoT for segment 1:

PoT = (90/85) x 100 = 106 percent

Similar calculations for segments 2 through 10 yield the following:

Table E-23 — Percent of Target Values for NB Lane

NORTHBOUND – Postmile 5 to 6										
	SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
PoT_{OGFC}	106	110	93	89	91	94	98	95	93	87

c. Use the PoT to determine the pay adjustment or course of action from the OGFC pay adjustment table.

   Based on the values of MRI_{TO} and calculated PoT for each segment, the OGFC pay adjustment table indicates that segments 1 and 2 are not within acceptable MRI thresholds of the specifications. The contractor may correct these areas at no cost to Caltrans or accept the disincentives. If the contractor elects to perform a corrective action, repeat the process by recalculating the PoT. The final outcomes can only result in full pay or remain as a disincentive. The MRI of segments 3 through 10 are within the expectations of the specifications and will receive full pay.

   Note that there is no incentive allowed on the OGFC surface.

   If the contractor accepts the disincentive instead of correcting, in accordance with the OGFC pay adjustment table, the pay adjustments are as follows:

Table E-24 — OGFC Pay Adjustment and Corrective Action for NB Lane

SEG	Pay Adjustment	Corrective Action
1	$600 disincentive	May only grind to meet ALR thresholds
2	$1,000 disincentive	May only grind to meet ALR thresholds
3	Full Pay	May only grind to meet ALR thresholds
4	Full Pay	May only grind to meet ALR thresholds
5	Full Pay	May only grind to meet ALR thresholds
6	Full Pay	May only grind to meet ALR thresholds

7	Full Pay	May only grind to meet ALR thresholds
8	Full Pay	May only grind to meet ALR thresholds
9	Full Pay	May only grind to meet ALR thresholds
10	Full Pay	May only grind to meet ALR thresholds

2. Areas of Localized Roughness

   No areas of localized roughness (ALR) exceeding 160 IRI are allowed. If there are segments that exceed this requirement, then the contractor must reduce ALR to meet the requirement at their own expense.

Southbound

1. Identify the applicable MRI_{SEG} pay adjustment for each segment of OGFC:
   a. In this example, OGFC is placed over RHMA overlay; therefore, locate the specific OGFC pay adjustment table that applies to this situation in the specifications.
   b. Determine the target MRI for OGFC (MRI_{TO}) and percent of target MRI for OGFC (PoT_{OGFC}).

The OGFC was laid over RHMA; therefore, it falls under section 39-2.04A(4)(c)(iii), "Pavement Smoothness of OGFC," of the *Standard Specifications*. The MRI_{TO} of each segment is equal to final MRI of the HMA layer. The following equation will be used to determine the percent of target MRI (PoT):

$PoT_{OGFC} = (MRI_{SEGO} / MRI_{TO}) \times 100$ percent rounded to the nearest 0.1 percent

In which:

MRI_{SEGO} = MRI of each 0.1-mile segment from PAVE profile for OGFC paving

MRI_{TO} = final MRI of the HMA layer on which OGFC is placed ($MRI_{FINALHMA}$)

Calculate the PoT_{OGFC} for segment 1:

$PoT_{OGFC} = (60/59) \times 100 = 102$ percent

Similar calculations for segments 2 through 10 yield the following:

Table E-25 — Percent of Target Values for SB Lane

SOUTHBOUND – Postmile 6 to 5										
	SEG 1	SEG 2	SEG 3	SEG 4	SEG 5	SEG 6	SEG 7	SEG 8	SEG 9	SEG 10
PoT_{OGFC}	102	109	110	110	100	81	89	98	83	80

c. Use the PoT to determine the pay adjustment or course of action from the OGFC pay adjustment table.

Based on the values of MRI_{TO} and calculated PoT_{OGFC} for each segment, the OGFC pay adjustment table indicates that MRI_{SEG} 1, 2, 3, and 4 are not within acceptable parameters of the specifications. The contractor does have the choice to correct these areas or accept the disincentives. If the contractor elects to do a corrective action, repeat the process by recalculating the PoT_{OGFC}. The final outcomes can only result in full pay or remain as a disincentive. The MRI on segments 5 through 10 are within the acceptable values of the specifications and will garner full pay.

Note that there is no incentive allowed on the OGFC surface.

If the contractor elects to accept the disincentive instead of correcting, in accordance with the OGFC pay adjustment table, the pay adjustments are as follows:

Table E-26 — OGFC Pay Adjustment and Corrective Action for SB Lane

SEG	Pay Adjustment	Corrective Action
1	$200 disincentive	May only grind to meet ALR thresholds
2	$900 disincentive	May only grind to meet ALR thresholds
3	$1,000 disincentive	May only grind to meet ALR thresholds
4	$1,000 disincentive	May only grind to meet ALR thresholds
5	Full Pay	May only grind to meet ALR thresholds

6	Full Pay	May only grind to meet ALR thresholds
7	Full Pay	May only grind to meet ALR thresholds
8	Full Pay	May only grind to meet ALR thresholds
9	Full Pay	May only grind to meet ALR thresholds
10	Full Pay	May only grind to meet ALR thresholds

2. Areas of Localized Roughness

   No ALR exceeding 160 IRI are allowed. If there are segments that exceed this requirement, the contractor must reduce ALR to meet the requirement at their own expense.

Step 2: Pay Adjustment Spreadsheet

In accordance with Section 36-3.01C(6)(c), "Payment Adjustment Spreadsheet," of the *Standard Specifications*, the contractor will submit a pay adjustment spreadsheet to Caltrans. A spreadsheet template is available at:

https://dot.ca.gov/programs/construction/pavement-smoothness

This spreadsheet contains all the formulas to automate the calculations previously shown for these examples. Based on the user input, the spreadsheet will calculate the pay quantities and provide the status of corrective actions.

Appendix F: Pay Adjustment Example

Prepare/Review Pay Adjustment Spreadsheet

The pavement smoothness pay adjustment spreadsheet is available at:

https://dot.ca.gov/programs/construction/pavement-smoothness

Under Payment Adjustment / Acceptance Worksheets and Checklists, you will find a pavement smoothness adjustment spreadsheet for HMA and concrete. Download the pay adjustment spreadsheet.

Before you begin, enable macros in this spreadsheet.

Note the worksheet names on each of the tabs along the bottom of the spreadsheet. The selected worksheet is named “PayAdj.” The “PayAdj” worksheet and the next four green tabbed worksheets are used by the contractor. The last four orange tabbed worksheets are used by the engineer.

MRI Data from the ProVAL > Ride Quality Module > Fixed Interval MRI report is exported by the contractor into the applicable green tabbed worksheets. As a check to make sure data was not modified after the contractor exported the MRI data to their worksheets, the engineer exports the same MRI data into the applicable orange tabbed worksheets. The yellow cells on this spreadsheet are for user input; all other cells are protected.

The contractor fills in the yellow cells in rows 2 through 8 from the top left to the lower right. Drop-down selection options are based on previously selected items. Upon receipt of the contractor’s payment adjustment request submittal, the engineer reviews the accuracy of the information in the yellow cells. To meet accessibility requirements, the orientation of the input cells has changed slightly from the graphics shown in the figures in this appendix. These accessibility improvements also added a double black border around cells that are designated as input cells.

If the contractor name field has not been filled in, you have the option of manually adding a contractor name to the top of the drop-down menu. You can do this by scrolling to the right portion of the worksheet where you will find “Use to change first name listed in contractor drop-down list” followed by a yellow cell. Once you add a contractor name here, go back to the contractor’s name cell and from the drop-down list, select the one you just added.

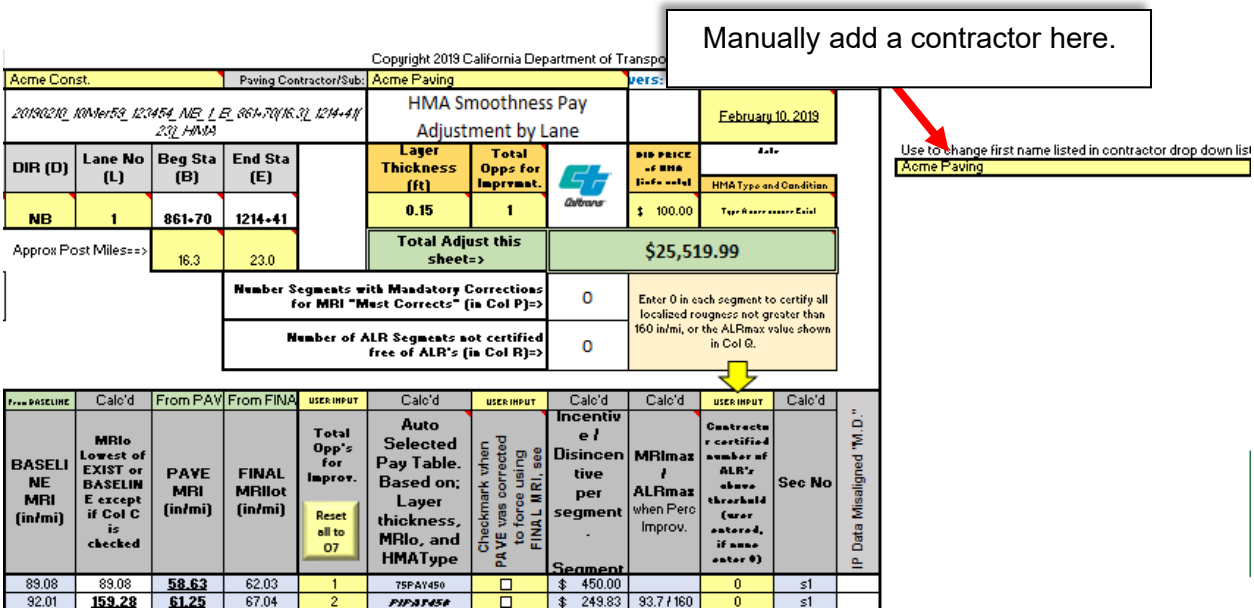


Figure F-1: Entering the contractor's name in the pay adjustment spreadsheet

The remaining data input into this worksheet will be used to generate the file name. The PVP file used to populate this worksheet should use the same name except end with .pvp.

Make sure all the data in the yellow cells on rows 2 through 8 is correct. Pay special attention to the three cells labeled "Layer Thickness," "Total Opp's for Improvement," and "HMA Type." These fields and MRI data determine payment adjustment tables to use.

Information on rows 2 through 8 and the first and last station from the imported "EXIST IP" MRI is used to set a unique file name.

Steps to import the MRI data follow. Once the EXIST MRI data is imported, use the SAVE FILE button to save the file. Use the PRINT button to print the report.

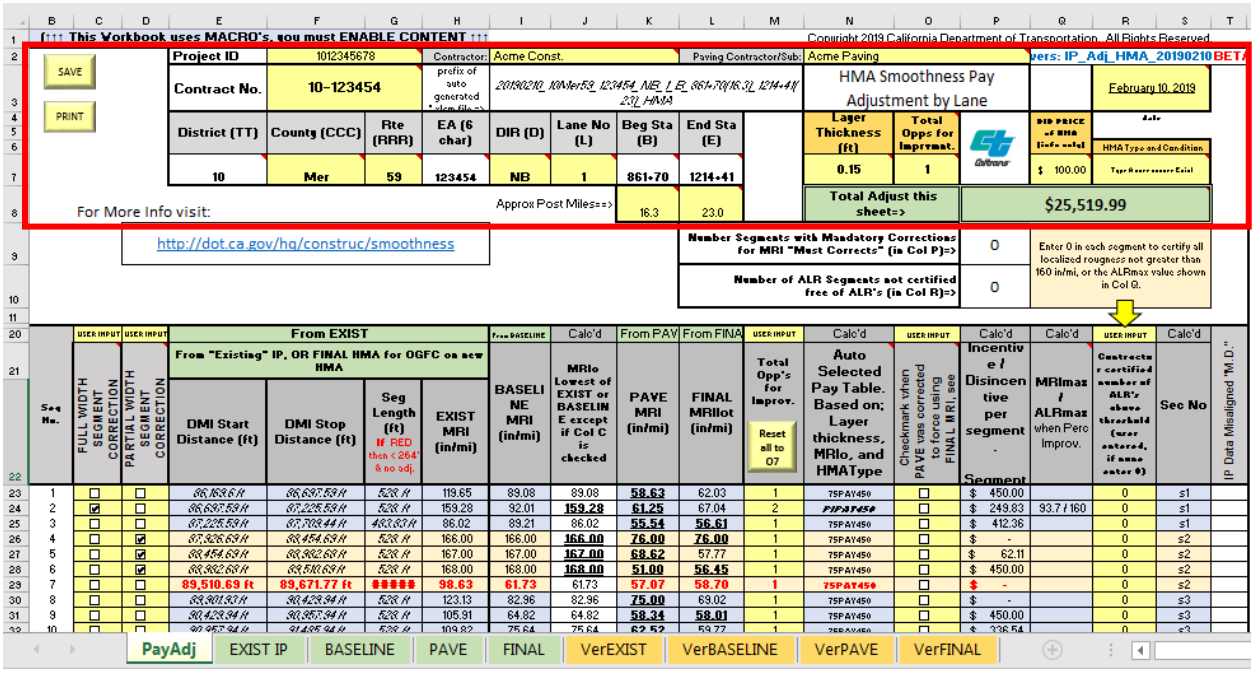


Figure F-2: Entering data in the yellow cells (rows 2-8) of the pay adjustment spreadsheet

Obtain Profile Data from ProVAL to Use in Pay Adjustment Spreadsheet

Opening the Contractor's PPV File Using ProVAL

In ProVAL, open the PPV file sent to you by the contractor. The PPV file must contain all the pavement profile (PPF) files required by the contract. The contractor will have already imported their MRI data into the green tabbed worksheets on the pay adjustment spreadsheet. You will then take the same profiles and import the same values into the orange tabbed worksheets to verify that the contractor's imported MRI data was taken directly from ProVAL and was not modified by the contractor. The steps to verify this are discussed in the following sections.

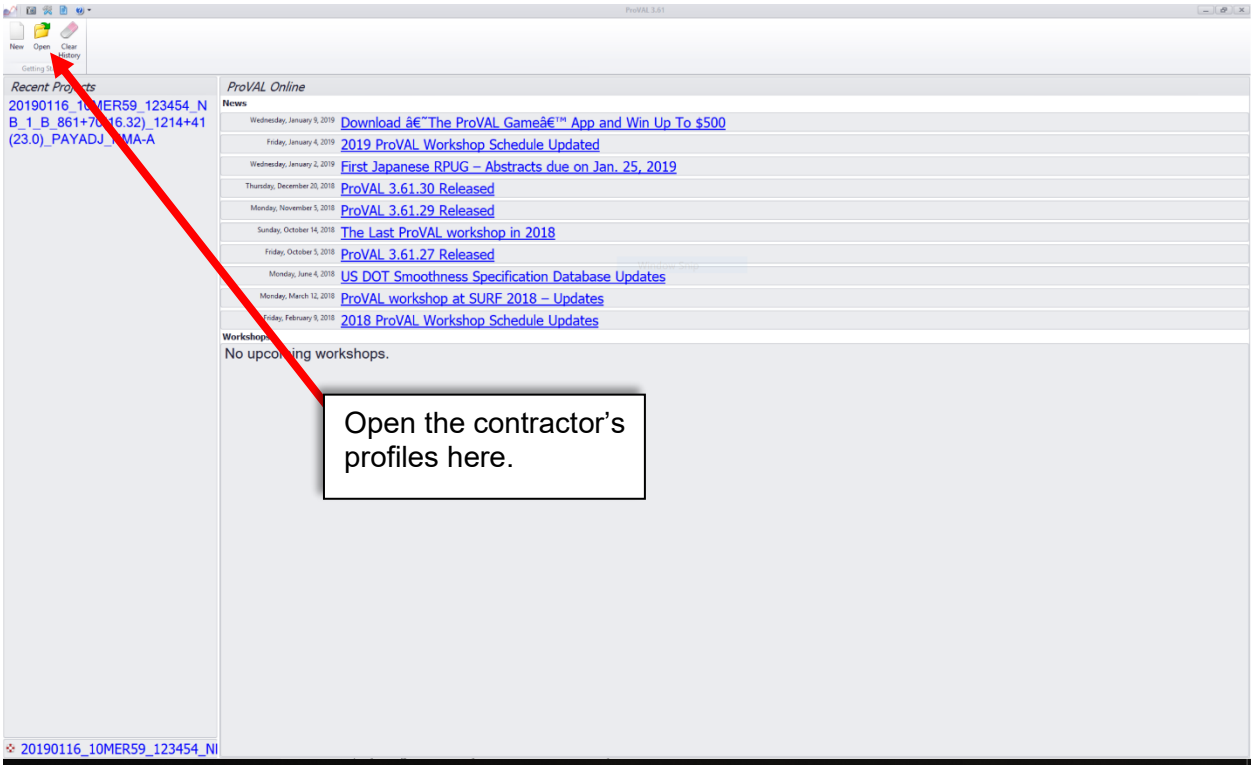


Figure F-3: Opening the contractor's PPV file using ProVAL

Use ProVAL to Generate the MRI Data for the Pay Adjustment Spreadsheet.

Once the files are opened in ProVAL, make sure you are in the correct analysis module.

At the top of the screen, select "Analysis" to open the drop-down menu and select "Ride Quality." You can verify you're in the correct analysis module by making sure it says, "Ride Quality," in the upper left; the button next to "Analysis" displays a car, and "Analysis RQ."

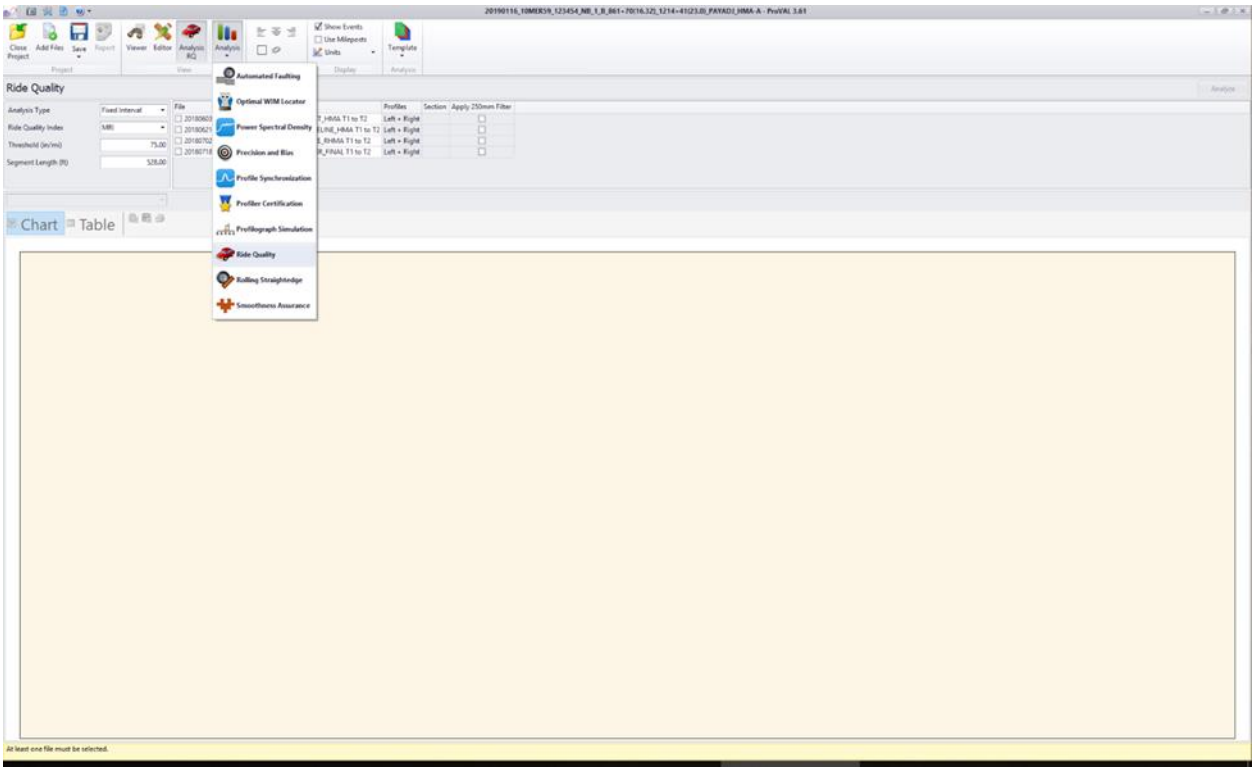


Figure F-4: Using ProVAL to generate the MRI data needed for the pay adjustment spreadsheet

Export Table and Place into Excel Pay Adjustment Spreadsheet

From the “Ride Quality” screen, set analysis type to “Fixed Interval,” set the ride quality index to “MRI,” the threshold value can be left “as is.” Select “all” the profiles and verify that each has the 250 millimeter filter applied, then click the “Analyze” button in the upper-right corner.

After the analysis is complete, to select the report for the applicable profile, select the drop-down menu immediately above the “Chart” button. Click “Table” button to view the 4-column table.

Export each of the four MRI tables (EXIST, BASELINE, PAVE, and FINAL) into the corresponding orange tabbed verification worksheets. After selecting the appropriate profile, repeat these steps for the remaining 3 profiles.

Select the applicable profile from the drop-down list immediately above the “Chart” button. In this example, we are selecting “EXIST” profile. In the Table view, right click on in the header row of the table and select “Copy table to clipboard” (Do not select “Copy table without column names.”)

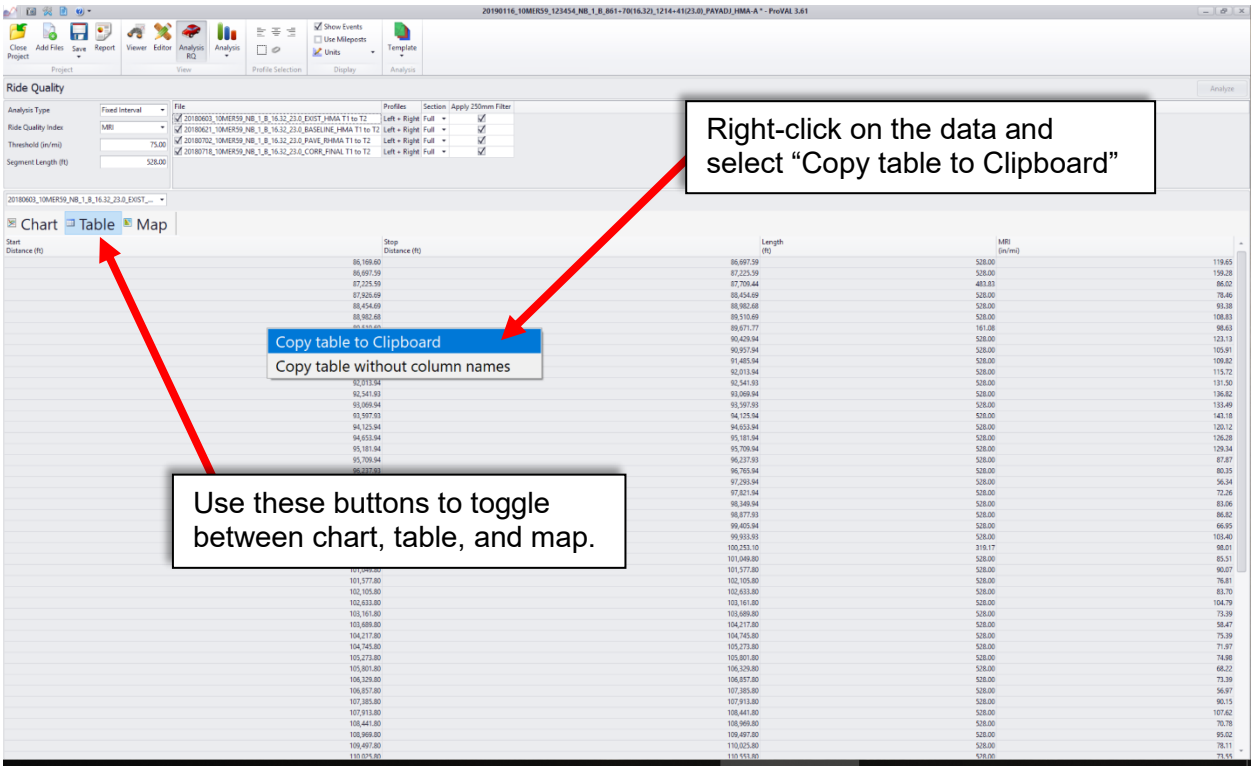


Figure F-5: Export from ProVAL into the pay adjustment spreadsheet (Excel file)

Open the payment adjustment spreadsheet.

Importing Data into the Pay Adjustment Spreadsheet

In the pay adjustment spreadsheet, the contractor will have populated the green worksheet tabs with their profile data. The engineer's verification tabs are orange. Once the contractor has input data, the engineer's tabs will display a large red section with negative values.

After selecting the applicable orange tabbed worksheet, right click on cell A1 and paste the data you copied from ProVAL into it.

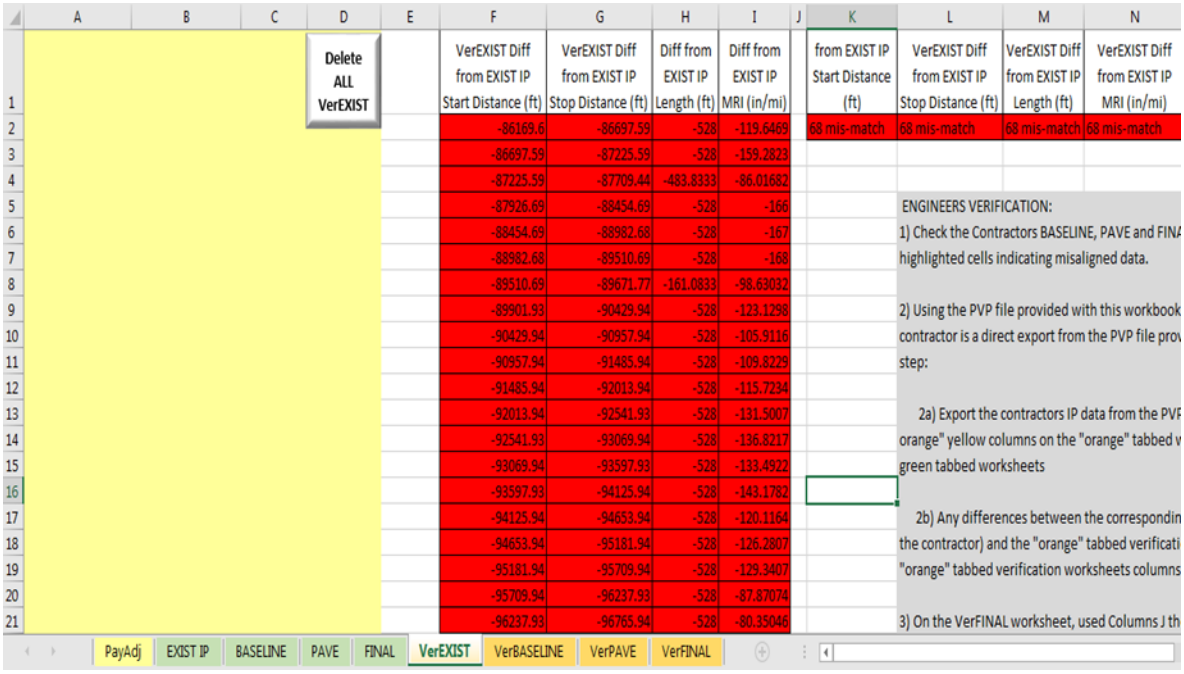


Figure F-6: Pasting the ProVAL data into the pay adjustment spreadsheet (Excel file)

Once you have pasted the data into the payment verification spreadsheet, you will see the yellow columns populated with the new data and columns F through I should now be blank and no longer red. Red will indicate areas where the values have been altered.

Import the remaining profiles from the contractor provided PVP file into the next three orange tabs labeled VerBASELINE, VerPAVE, and VerFINAL. The VerFINAL tab is discussed in the following section, "Exporting overall MRI data from ProVAL to the payment adjustment 'VerFINAL' worksheet."

What if I See Red in Columns F through N?

Any red in columns F through N will indicate a difference between the MRI data you imported directly from ProVAL and the contractor's MRI data from the same PVP file. The specifications prohibit manually changing MRI data on the payment adjustment spreadsheet. If the MRI data is not the same, reject the contractor's payment request. Section 36-3.01C(6)(c) "Payment Adjustment Spreadsheet," of the *Standard Specifications* requires that the data is directly imported from ProVAL.

F	G	H	I	J	K	L	M	N
VerEXIST Diff from EXIST IP Start Distance (ft)	VerEXIST Diff from EXIST IP Stop Distance (ft)	VerEXIST Diff from EXIST IP Length (ft)	VerEXIST Diff from EXIST IP MRI (in/mi)		VerEXIST Diff from EXIST IP Start Distance (ft)	VerEXIST Diff from EXIST IP Stop Distance (ft)	VerEXIST Diff from EXIST IP Length (ft)	VerEXIST Diff from EXIST IP MRI (in/mi)
			-0.3531		All Match	All Match	All Match	1 mis-match

Figure F-7: Red cells in the pay adjustment spreadsheet, as shown, indicate a mismatch with data imported directly from ProVAL.

Exporting Overall MRI Data from ProVAL to the Payment Adjustment "VerFINAL" Worksheet

For the VerFINAL tab, you will need to obtain the overall MRI from ProVAL. Make sure all profiles are selected. For analysis type, select "Overall." For ride quality index, select "MRI." Then run the analysis and right click on the data. When you export data, select to copy table without column names.

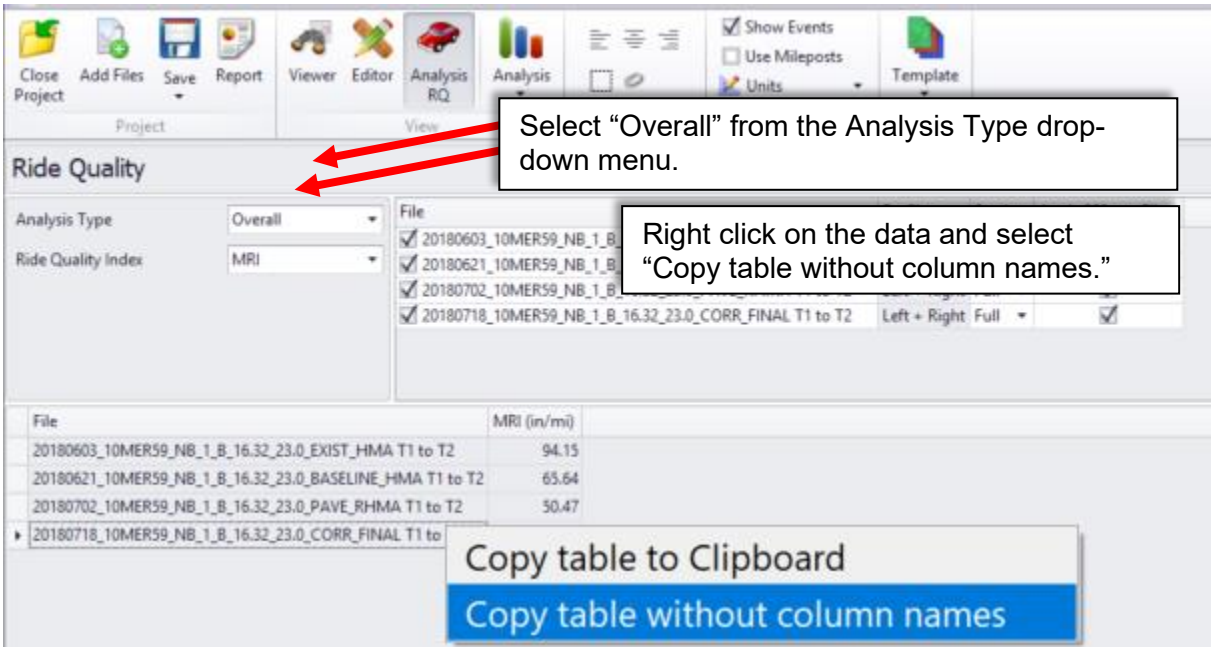


Figure F-8: Exporting overall MRI data from ProVAL to the payment adjustment VerFINAL worksheet

Paste the Overall MRI data you copied from ProVAL into rows 6-8 on the VerFINAL worksheet.

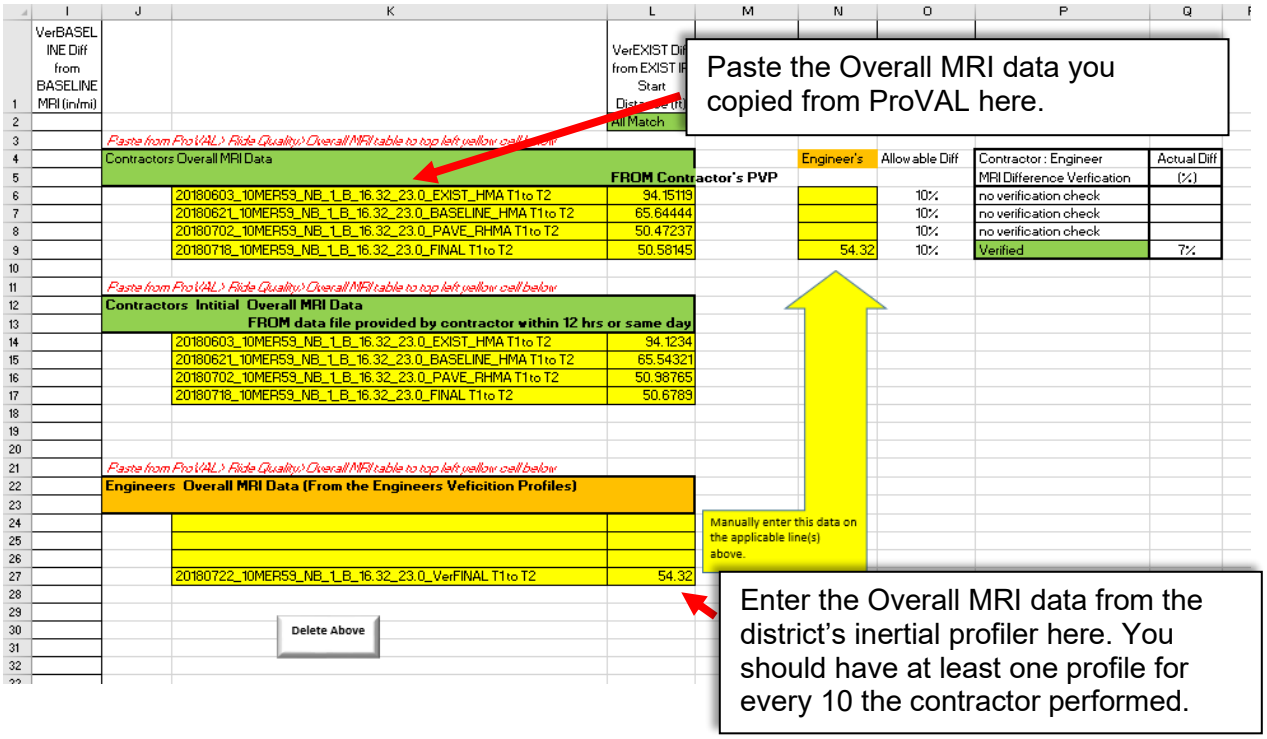


Figure F-9: Pasting the Overall MRI data from ProVAL to the VerFINAL worksheet within the pay adjustment spreadsheet

Run Checks of Data

Once all of the profile data has been entered into the corresponding tabs, review the “PayAdj” tab, understand what the analysis means, and know what to look for before approving a contractor’s pay adjustment request. You need to verify that the values entered into the yellow cells by the contractor are correct.

Difference in Row Colors

This data will carry over to this worksheet in columns E through H from line 23 down. Rows are colored to indicate sections defined by leave-outs, where leave-outs are determined to follow partial segment lengths.

Layer Thickness, Total Opportunities for Improvement, and HMA Type / Condition

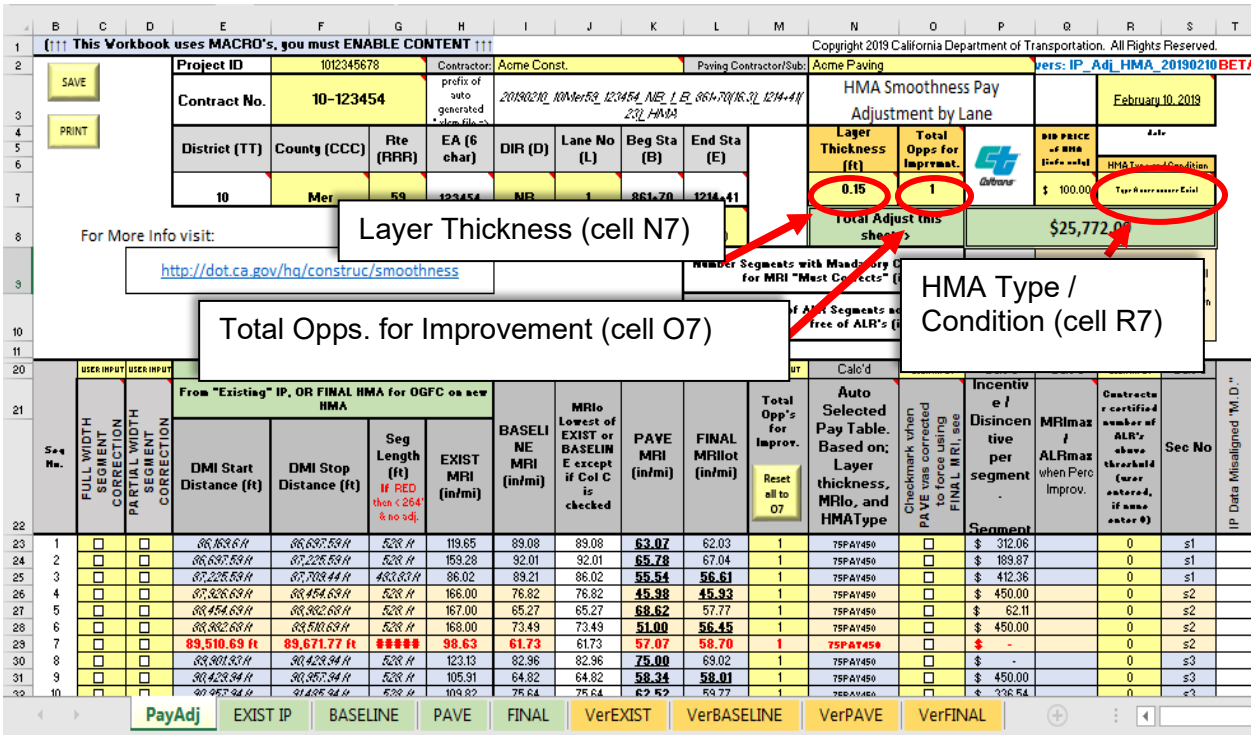


Figure F-10: Verify the contractor’s values

Verify the contractor entered the correct values for Layer Thickness (cell N7), Total Opp’s for Improvement (cell O7), and HMA Type and Condition (cell R7). These values are the primary cells that determine which of the many tables will be used. Incorrect entries in these cells will yield an incorrect payment adjustment. The value entered in cell O7 carries down to each segment in column M. The values in column M can be individually overridden within each segment, which may be necessary if “Segment Corrections” are implemented or if typical sections allow some but not all segments to be cold planed in a different shift than paving. Overriding the column M values erases the cell reference to O7. If you need to reset all values in column M to the value in cell O7, click the yellow “Reset all to O7” button in column M. Clicking the “Reset all to O7” button replaces the equations built in to column M to use the value in cell O7.

"Segment Correction" Prepaving Corrections, and Pave Surface Correction

Prepaving corrections are designated on the plans by inclusion of bid items for segment corrections. When work is performed, verify that the payment adjustment sheet has a check mark in column C.

When a check mark in column C for segment corrections is used, and the specifications do not require the segment corrections to be paved over in the same shift, verify that the contractor increases the opportunities for improvement in column M by one. The check mark in column C forces the MRI_0 value to be from the EXIST profile rather than the lower of EXIST or BASELINE.

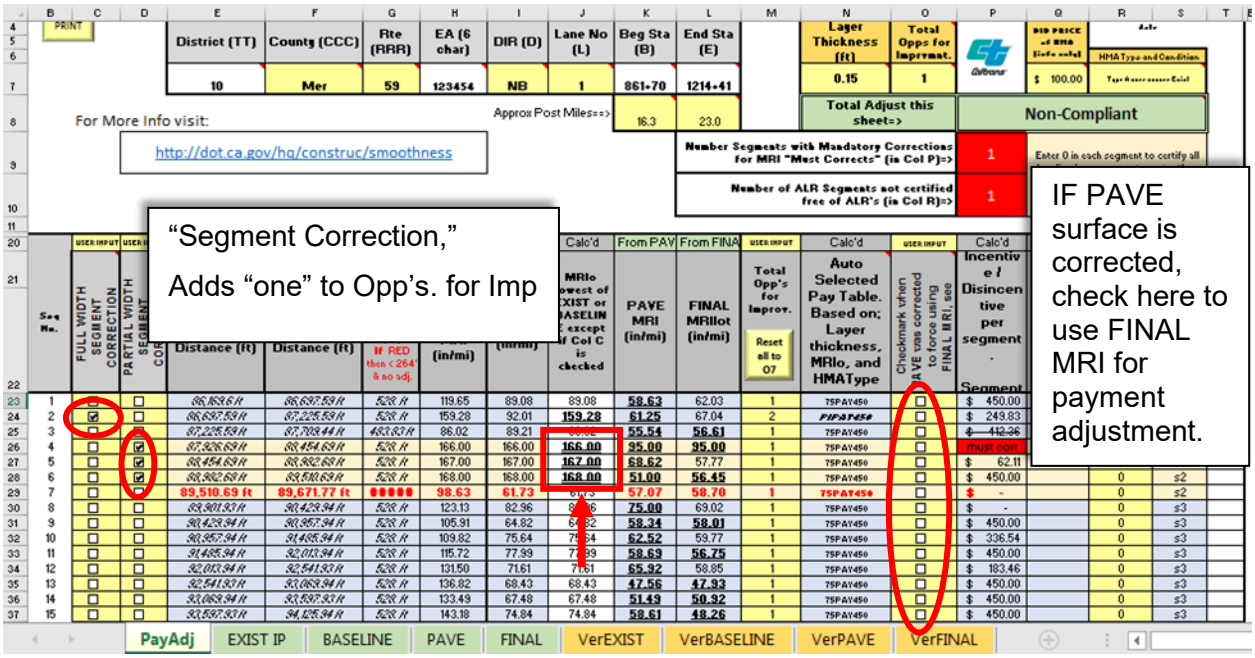


Figure F-11: Verify whether the contractor has appropriately indicated the Prepaving Corrections and Pave Surface Correction

Review "PayAdj" Worksheet and Reject if Any Cells are Highlighted Red

Review the pay adjustment worksheet for any red highlights, which indicates errors in the contractor's data. Red highlights may appear in:

Table F-1 - Locations on Pay Adjustment Worksheet to Review for Red Highlights

Cell P9	Red indicates that the contractor did not certify all segments to be free of localized roughness in column R. Note: You will later need to verify this.
Cell P10	Red indicates that the contractor has one or more segments requiring mandatory corrections for MRI. The locations are shown in Column P with red highlighted "must corr."
Column T	Red indicates misaligned data.

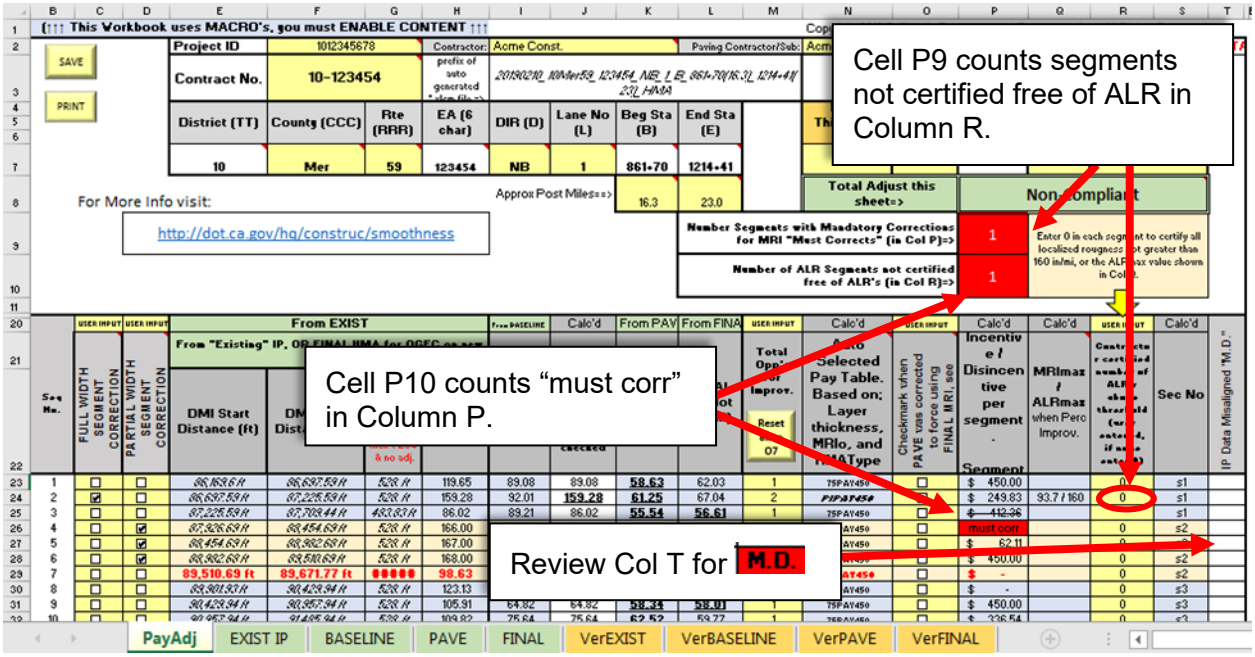


Figure F12: Reviewing the pay adjustment spreadsheet for cells that are red

If, after reviewing the spreadsheet, you discover any red highlights, reject the contractor's submittal, and request the appropriate adjustments.

Check the Contractor's Claim that All Areas of Localized Roughness have Been Addressed

The contractor is required to enter "0" in Column R on each row to indicate that they have resolved all ALR issues in each 0.10-mile segment or portion thereof. The spreadsheet will not provide a total dollar adjustment if the contractor has not indicated that all segments are free of ALR issues. In the following example, values are calculated as follows: the segment has 2 opportunities for improvement, so use the two-opportunity equation to calculate MRI_T, $MRI_T = 0.1\ MRI_0 + 50$. $MRI_T = 0.1 \times 159.28 + 50 = 65.93$. Because the layer thickness is < 0.30 foot, the incentive/disincentive is based on the table for thickness < 0.30 foot. The final MRI after

correction (MRI_{SEG}) for that segment is given and is equal to 67.04 and the calculated MRI_T is 65.93. This falls under the range of $MRI_T - 5 < MRI_{SEG} \leq MRI_T + 5$, which makes it Full Pay. $ALR_{MAX} = 2.1 \times MRI_T = 65.93 \times 2.1 = 138.45$, but the ALR_{MAX} also has a floor value of 160 inches per mile, so the ALR_{MAX} is 160 inches per mile.

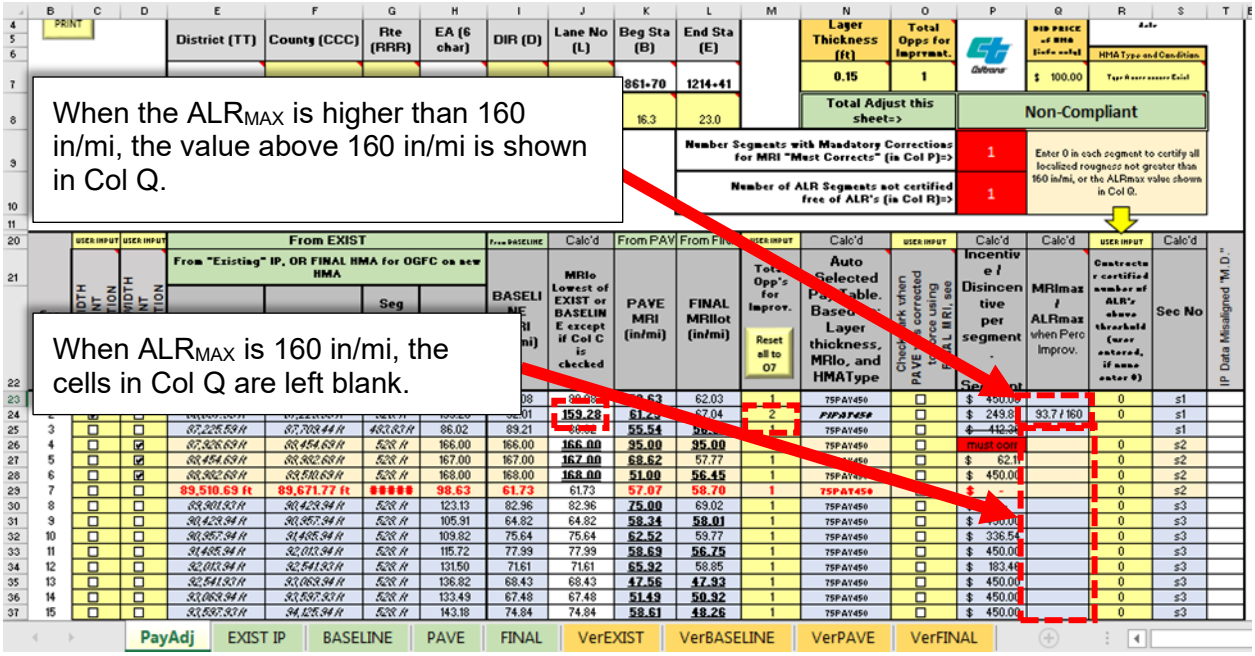


Figure F-13: Checking the ALR values in the pay adjustment spreadsheet

To check that the contractor has resolved all ALR issues, evaluate each wheel path of the FINAL profile the using the ProVAL Ride Quality > Continuous > IRI report using the settings shown:

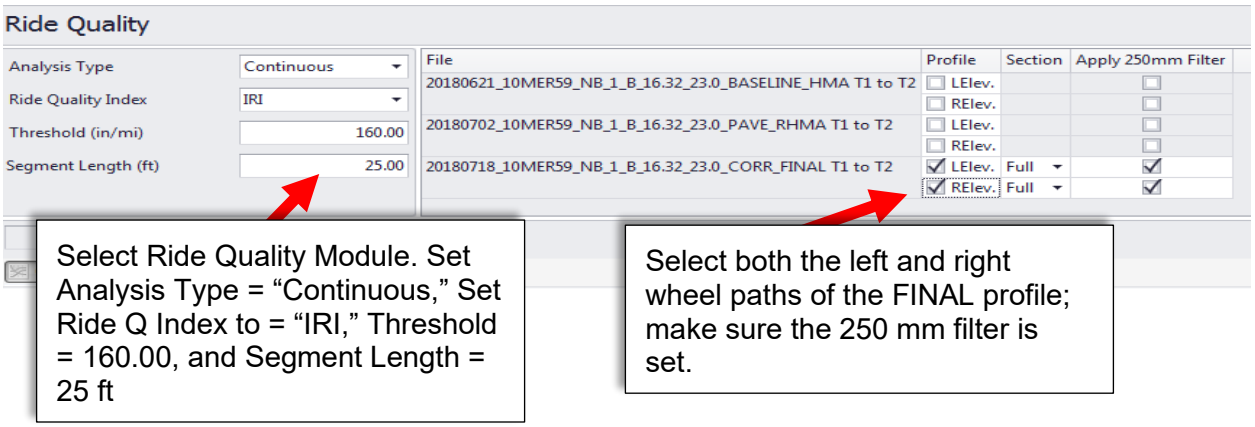


Figure F-14: Evaluating each wheel path in ProVAL to verify that ALR issues have been addressed

Once the report is run, you can review the chart form or tabular form for any localized roughness exceeding 160. Check column Q to determine if the ALR threshold for that segment is higher than 160. If the contractor indicated all zeros in column Q, and there are still ALR threshold violations in the FINAL file, reject the payment adjustment request and note the non-conformance of the ALR threshold.

Following is an example of the chart of the localized roughness report. A review of column Q on the payment adjustment worksheet indicates there is only one segment with a threshold higher than 160 inches per mile between DMI locations 86,697.59 feet and 87,225.59 feet. This location does not coincide with the areas of localized roughness, so the contractor's payment adjustment request submittal would be rejected. Clicking the table would provide the station locations where the wheel paths' ALR values cross over the 160 inches per mile threshold.

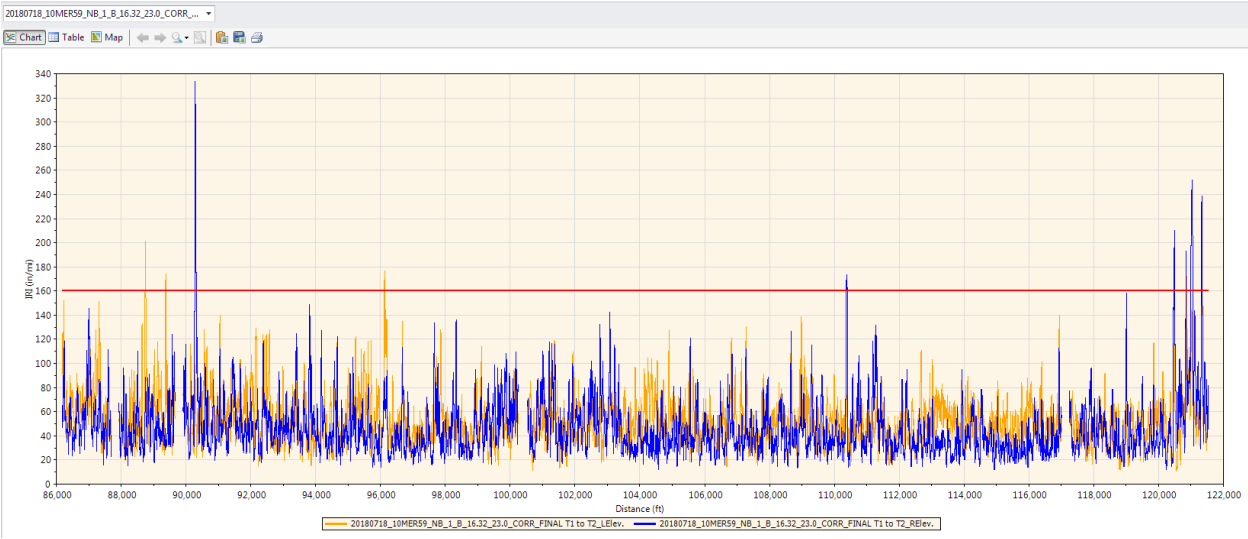


Figure F-15: ALR graph from ProVAL. The red horizontal line is the 160 in/mi threshold

If none of the data has been flagged by red highlights, proceed with the next steps.

Check for Data Manipulation

The specifications require the contractor to import data directly from ProVAL and copy into rows A, B, C, and D of the green tabbed worksheets. The contractor must not change these values. The “orange” tabbed worksheets allow the engineer to import the same data without changing the contractor’s data. Any differences are highlighted in red on the orange-tabbed worksheets.

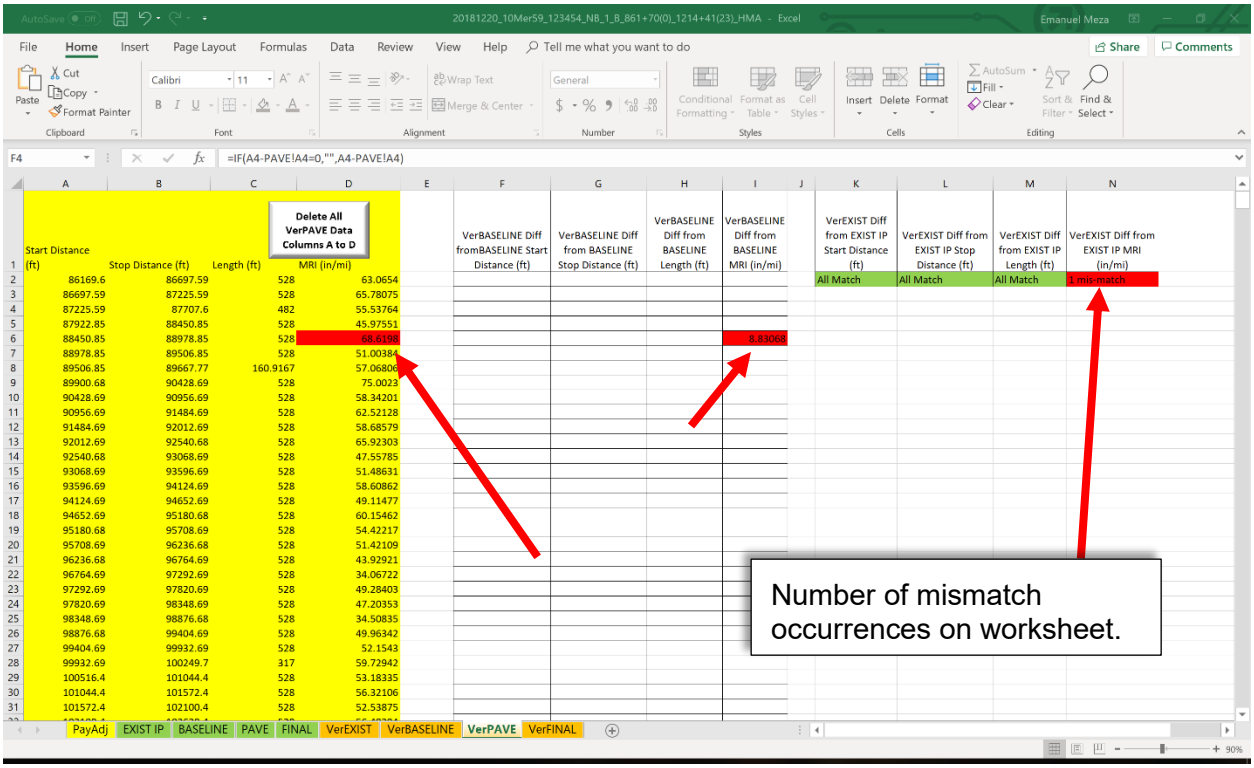


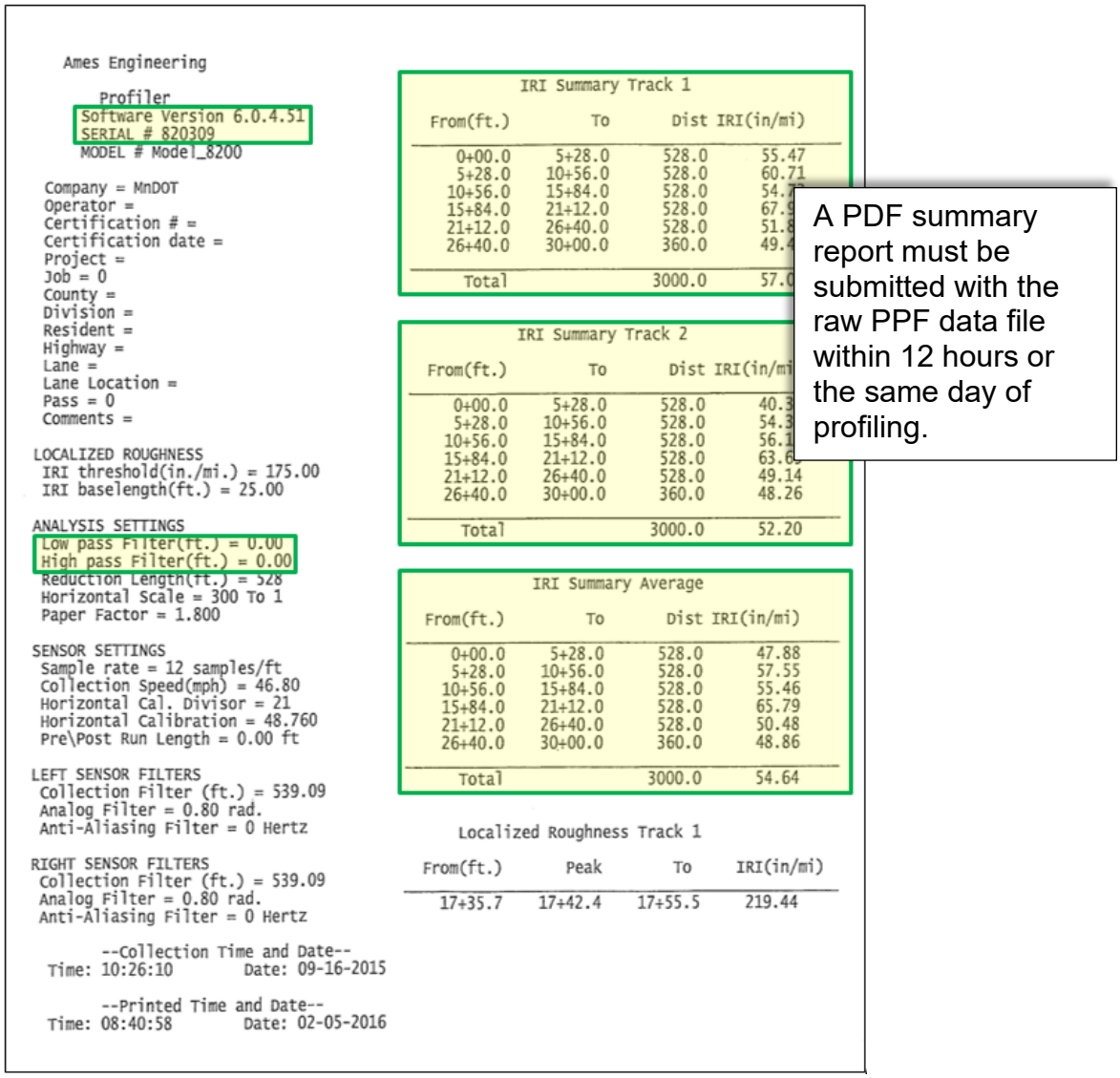
Figure F-16: Checking for data mismatches

Any mismatch between the verification profiles and the contractor’s profiles will be highlighted in columns A through D. Columns F through I will show the amount by which the profile values differ. Columns K through N will verify that values on the worksheet match and will tally the number of mismatch occurrences on the worksheet.

Verify that profiles used in PVP are from the profiles initially submitted the day the profiles were run

Compare the Initial PDF or Printout to ProVAL Data in the Payment Adjustment Request

Compare the initial PDF or printout that the contractor submitted within 12 hours of running their profiles to the ProVAL data in the payment adjustment request. The printouts should list fixed 528-foot fixed-interval IRI values and the overall average. These values may not match exactly, but they should be close to the MRI values reported by the contractor.



Ames Engineering

Profiler
Software Version 6.0.4.51
SERIAL # 820309
MODEL # Model_8200

Company = MnDOT
Operator =
Certification # =
Certification date =
Project =
Job = 0
County =
Division =
Resident =
Highway =
Lane =
Lane Location =
Pass = 0
Comments =

LOCALIZED ROUGHNESS
IRI threshold(in./mi.) = 175.00
IRI baselength(ft.) = 25.00

ANALYSIS SETTINGS
Low pass Filter(ft.) = 0.00
High pass Filter(ft.) = 0.00
Reduction Length(ft.) = 528
Horizontal Scale = 300 To 1
Paper Factor = 1.800

SENSOR SETTINGS
Sample rate = 12 samples/ft
Collection Speed(mph) = 46.80
Horizontal Cal. Divisor = 21
Horizontal Calibration = 48.760
Pre\Post Run Length = 0.00 ft

LEFT SENSOR FILTERS
Collection Filter (ft.) = 539.09
Analog Filter = 0.80 rad.
Anti-Aliasing Filter = 0 Hertz

RIGHT SENSOR FILTERS
Collection Filter (ft.) = 539.09
Analog Filter = 0.80 rad.
Anti-Aliasing Filter = 0 Hertz

--Collection Time and Date--
Time: 10:26:10 Date: 09-16-2015

--Printed Time and Date--
Time: 08:40:58 Date: 02-05-2016

IRI Summary Track 1

From(ft.)	To	Dist	IRI(in/mi)
0+00.0	5+28.0	528.0	55.47
5+28.0	10+56.0	528.0	60.71
10+56.0	15+84.0	528.0	54.7
15+84.0	21+12.0	528.0	67.9
21+12.0	26+40.0	528.0	51.8
26+40.0	30+00.0	360.0	49.4
Total		3000.0	57.0

IRI Summary Track 2

From(ft.)	To	Dist	IRI(in/mi
0+00.0	5+28.0	528.0	40.3
5+28.0	10+56.0	528.0	54.3
10+56.0	15+84.0	528.0	56.1
15+84.0	21+12.0	528.0	63.6
21+12.0	26+40.0	528.0	49.14
26+40.0	30+00.0	360.0	48.26
Total		3000.0	52.20

IRI Summary Average

From(ft.)	To	Dist	IRI(in/mi)
0+00.0	5+28.0	528.0	47.88
5+28.0	10+56.0	528.0	57.55
10+56.0	15+84.0	528.0	55.46
15+84.0	21+12.0	528.0	65.79
21+12.0	26+40.0	528.0	50.48
26+40.0	30+00.0	360.0	48.86
Total		3000.0	54.64

Localized Roughness Track 1

From(ft.)	Peak	To	IRI(in/mi)
17+35.7	17+42.4	17+55.5	219.44

A PDF summary report must be submitted with the raw PPF data file within 12 hours or the same day of profiling.

Figure F-17: PDF summary report from profiler (Ames brand)

Also compare the overall MRI values of the PPF files you received within 12 hours or the same day as profiling with the MRI data taken from PVP file submitted with the payment adjustment request.

The table in cells K14:L17 are provided so that you can export the overall MRI data from these raw data files into the worksheet. You can open and analyze the PPF files using ProVAL by double clicking the PPF file name. Once open, use the Ride Quality > Overall > MRI report to produce a single row table that can be pasted into one of the rows 14 – 17.

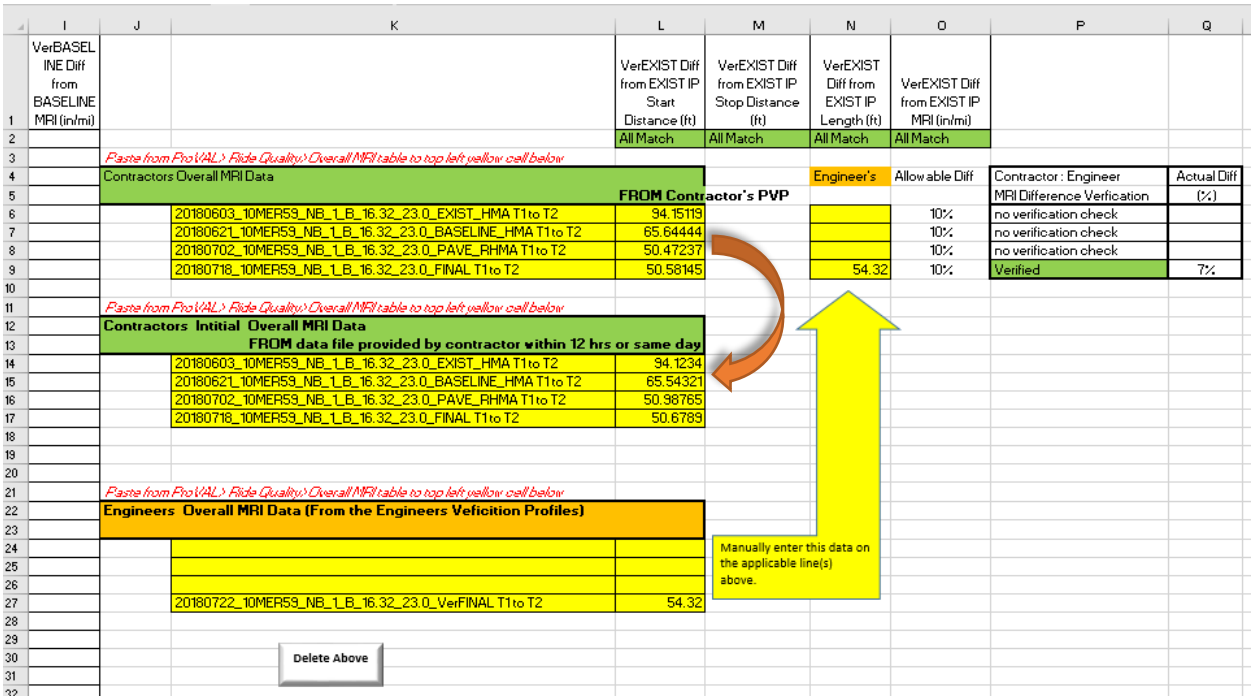


Figure F-18: Evaluating the overall MRI values

Optional: Run the Overall MRI Report from the Initial PPF Files and Enter Them on the VerFINAL Worksheet Cell K14 to L17

Verify a Minimum of 10 Percent of the Contractor's Profiles

Use the engineer's profiles to verify the contractor's profiles used for payment request. Caltrans policy requires that you run a minimum of 1 profile for every 10 the contractor runs. Your verification profile should be run using the same lane and the same beginning and ending semi-permanent reference points.

Locate the PPF file provided to you by your district's inertial profiler. Run the Ride Quality > Overall > MRI report to produce a single row table that can be pasted into one of the rows 24 – 27. Manually copy the applicable MRI value to cells N6:N9.

Payment

The pay adjustment spreadsheet will not calculate the total adjustment and will display “Non-Compliant” until all issues have been addressed by the contractor.

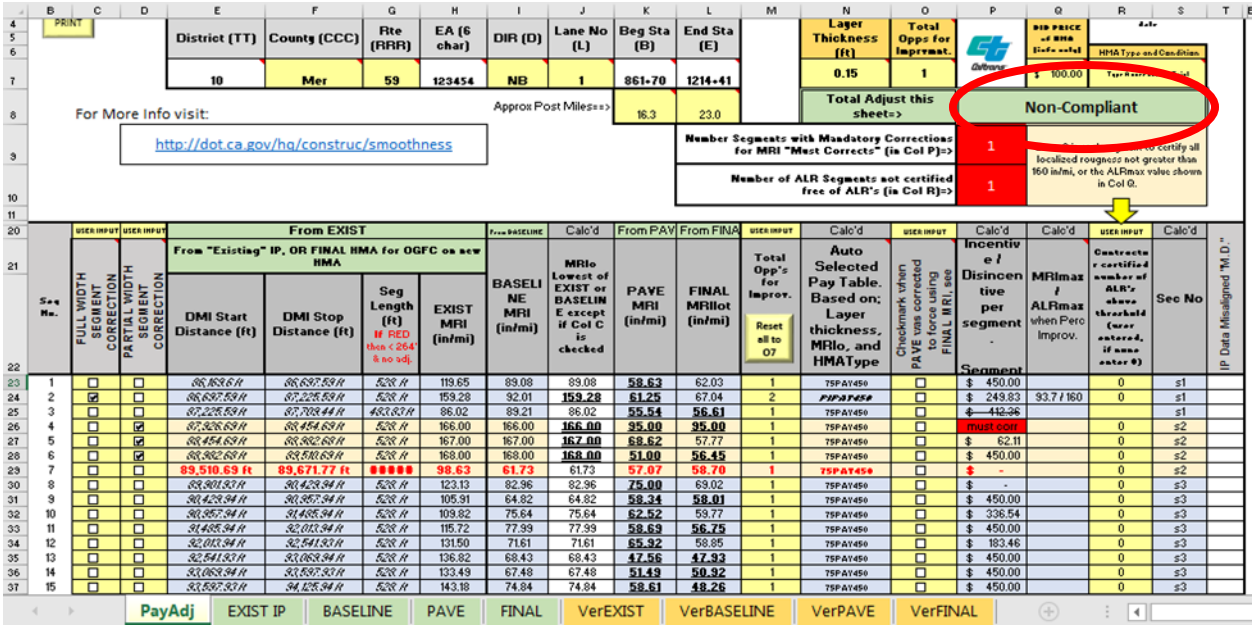


Figure F-19: This pay-adjustment spreadsheet still has issues for the contractor to address, so the adjustment indicates “Non-Compliant”

Once all issues have been addressed; the spreadsheet will calculate and display the adjustment amount.

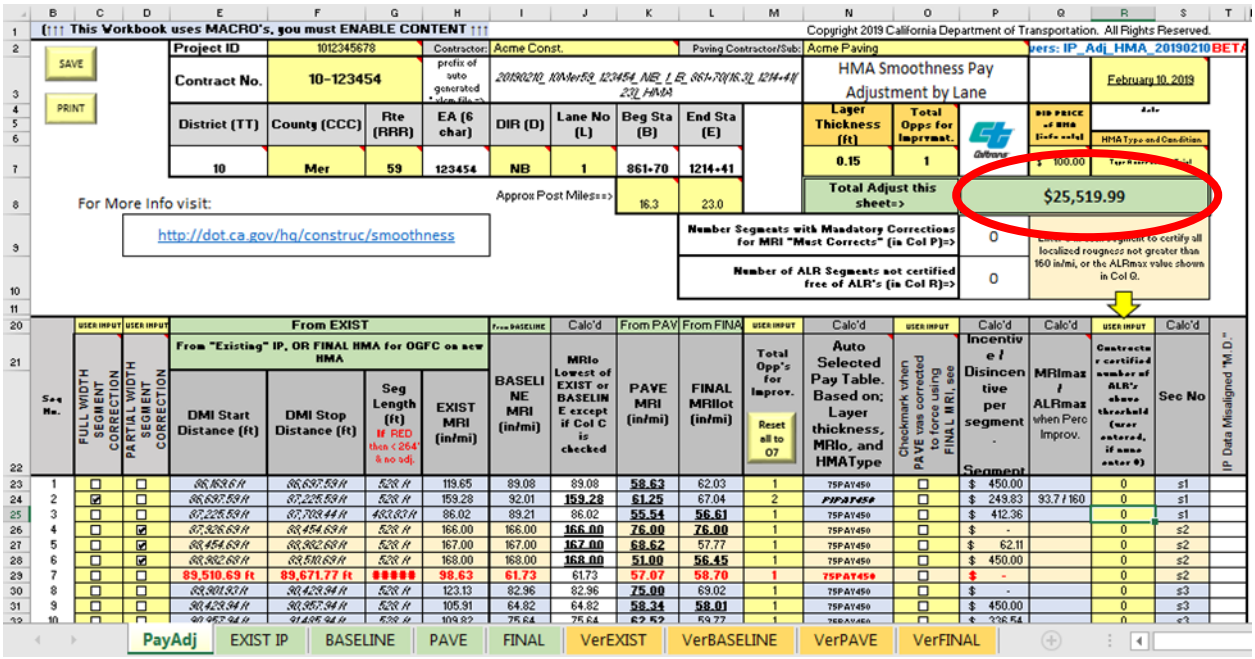


Figure F-20: The spreadsheet has calculated and displayed the pay adjustment amount

Summary

The engineer uses this spreadsheet for payment purposes only after taking the following steps:

1. Verify all MRI values are not in the “must correct” range. This is summarized in cell P9 and segments that are “must correct” are shown in Column P.
2. Verify that the contractor certified that all ALR issues were resolved by entering a zero in Column R for each segment. This is summarized in cell P10. ALR thresholds are 160 inches per mile, unless shown otherwise in Column Q.
3. Verify that the contractor’s MRI data imported into the green tabbed worksheets was taken directly from ProVAL. The engineer makes this check by importing the same MRI data into the orange tabbed verification worksheets.
4. Verify the PPF files contained in the PVP file are from the same PPF files the engineer witnessed: on the VerFINAL worksheet, the Overall MRI values from the PVP in cells K6:L9 and the Overall MRI values from the PPF files received the same day as profiling.
5. Use the district’s inertial profiler to verify the contractor’s profiles at a minimum frequency of 1:10. Compare Overall MRI values of the same surface between the same beginning and ending semi-permanent reference points. Enter the engineer’s Overall MRI values in K24:L27 on the VerFINAL worksheet. Overall MRI values are verified if within 10 percent of each other.

Appendix G: Asphalt Smoothness Design Checklist

The design checklist is meant to be used as an aid and may not include every project scenario. The main purpose of the checklist is to assist project engineers during the design phase on pavement rehabilitation projects. For new construction projects, smoothness is addressed during construction. Project engineers are encouraged to exercise best engineering judgment and to consult with the district pavement experts. The following table is from the smoothness guidelines for concrete and asphalt concrete on the Division of Maintenance Pavement Smoothness internal web page.

Please refer to this website for the latest version of the guidelines.

Table G-1 — Design Checklist

At Design Initiation		
TASK	**Date**	**By**
1. Review the project report to validate the pavement strategy.	_____	_____
2. Perform field review to assess field conditions. Include the district pavement engineer and maintenance supervisor.	_____	_____
3. Request inertial profiler data.	_____	_____
4. Select the best location to set a semi-permanent reference point. The reference point should be identified by station and offset along with GPS coordinates. Work with the district surveyors for best location.	_____	_____
During Plan Development		
5. Analyze inertial profile raw data and determine the existing MRI using ProVAL.	_____	_____
6. Using the existing MRI from the previous task, validate the pavement strategy documented in the project report.	_____	_____
7. Determine the target MRI for the project given the existing MRI and pavement strategy.	_____	_____
8. Analyze the existing MRI data and determine if segments of pavement require prepaving corrections.	_____	_____

Within 6 months of Achieving the Ready To List Milestone		
9. Request updated inertial profile data for verification and advertisement. This may result in project schedule delay of advertisement date if the updated MRI is significantly different from the MRI data from task 5.	_____	_____
10. Based on the MRI data analyzed, quantify the pavement 0.1-mile segments that need prepaving corrections.	_____	_____
11. Estimate the segment correction and include it in the project plan sheets and estimate.	_____	_____
12. Estimate the funds required for the possible smoothness incentive and include smoothness correction as a supplemental work in the project estimate.	_____	_____
Resident Engineer Pending File		
13. Latest inertial profile raw data for each lane obtained at task 9.	_____	_____
14. ProVAL ride quality analysis report for MRI of each lane. Submit in PDF file format.	_____	_____
15. Semi-permanent control points for inertial profile data provided. Submit in GPS exchange file format and include station and offset for each point.	_____	_____
16. Design tables used to analyze areas that need prepaving corrections.	_____	_____
Information Handout		
17. Include the latest inertial profile raw data for each lane obtained at task 9.	_____	_____

Appendix H: Memo from Deputy Directors "Providing Pavement Profile Smoothness Data"

State of California
DEPARTMENT OF TRANSPORTATION

California State Transportation Agency

Memorandum

Serious drought.
Help save water!

To: DISTRICT DIRECTORS

Date: August 15, 2016
File: Pavement Smoothness

From: STEVE TAKIGAWA
Deputy Director
Maintenance and Operations

KARLA SUTLIFF
Deputy Director
Project Delivery

Subject: PROVIDING PAVEMENT PROFILE SMOOTHNESS DATA

To the traveling public, smoothness is one of the most important pavement features. Pavement profile smoothness for pavement rehabilitation, maintenance, and preservation projects needs to be addressed early during the project design stage to ensure improvement in the pavement profile smoothness.

Starting in February 2013, the California Department of Transportation (Caltrans) transitioned to using a high-speed inertial profiler (IP) for measuring pavement profile smoothness. The IP provides accurate pavement profile smoothness measurements at highway speeds, collects profile measurements of both wheel paths at the same time, eliminates the need for lane closures, and reduces employee exposure to traffic. The IP measures pavement profile smoothness using the International Roughness Index (IRI), which is the same index Caltrans uses to report annual network level pavement smoothness. Data collected by the IP is analyzed using the Federal Highway Administration's ProVAL software.

To ensure all bidders have the same basis for bidding on hot-mix asphalt and concrete pavement projects, the districts will now provide to bidders the existing pavement profile smoothness data taken within six months of the project's ready-to-list (RTL) milestone. The existing pavement profile smoothness data provided must comply with the requirements in the attached "Guidelines for Providing Electronic Pavement Profile Smoothness Data Files in Project Information Handouts." The data also must be listed as supplemental project information in section 2–1.06B of the project special provisions and provided in the project information handout. These requirements will be mandatory for projects with an RTL milestone after September 15, 2016.

If you have any questions about pavement smoothness, please contact Sri Balasubramanian, chief of the Office of Asphalt Pavement in the Division of Maintenance—Pavement Program, at (916) 274-6194 or by e-mail sent to <balasubramanian@dot.ca.gov> or Ken Darby, chief of the Office of Concrete Pavements at (916) 227-5845 or by e-mail sent to <ken.darby@dot.ca.gov>.

Attachment

c: Director Malcolm Dougherty
Chief Deputy Director Kome Ajise
Tony Tavares, Chief, Division of Maintenance
Rachel Falsetti, Chief, Division of Construction
Tom Pyle, Acting State Pavement Engineer,
Division of Maintenance—Pavement Program
Sri Balasubramanian, Chief, Office of Asphalt Pavement,
Division of Maintenance—Pavement Program
Chuck Suszko, Chief, Office of Construction Engineering,
Division of Construction

ATTACHMENT

GUIDELINES FOR PROVIDING ELECTRONIC PAVEMENT PROFILE SMOOTHNESS DATA FILES IN PROJECT INFORMATION HANDOUTS

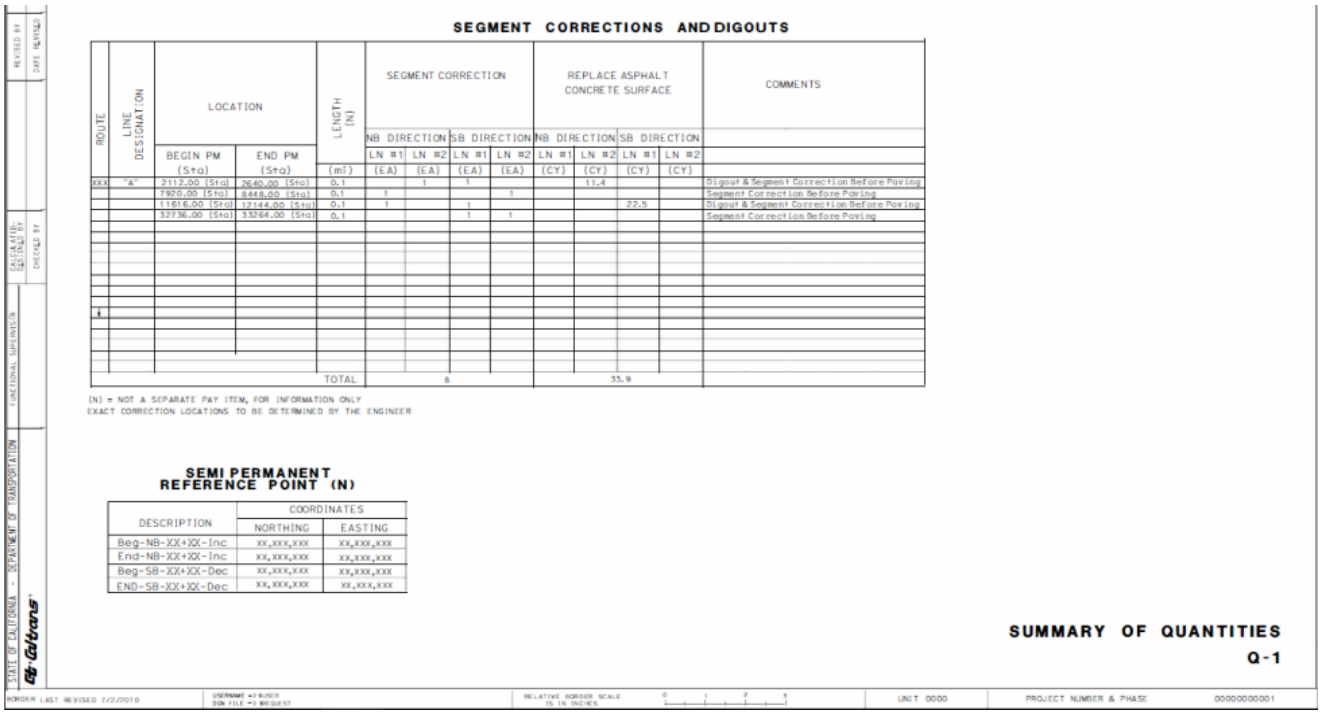
DATA COLLECTION

- Ensure inertial profile operator and equipment are certified as of the date of data acquisition.
- Operate the inertial profiler under the manufacturer's instructions and AASHTO R 57 at 1-inch recording intervals. For concrete pavement, use a minimum 4-inch line laser sensor.
- Collect profile data under AASHTO R 56.
- Provide semipermanent markings on the pavement at the starting and ending stations of the profiles.
- Include 200 feet run-on and 200 feet run-off lengths that extend beyond the limits of construction, where practical.
- Identify the beginning and ending of significant events including:
  - Bridge approach slabs.
  - Bridges.
  - Culverts visible on the roadway surface.
  - At-grade intersections.

DATA FILES

- Provide individual files for each existing traffic lane within the project limits that captures both left and right wheel paths. A traffic lane is any lane more than 1,000 feet in length, including ramps, turn lanes, and acceleration and deceleration lanes. All lanes where work is to be performed within the project limits must be profiled. Provide pavement profiles for existing adjacent lanes that may affect construction operations directly or indirectly, such as concrete pavement widening that requires grinding of the existing adjacent lane.
- Identify in the data files leave-outs such as bridges.
- Follow the file naming convention identified in section 36–3, "Pavement Smoothness," of the 2015 *Standard Specifications*; that is,
  "YYYYMMDD_TTCCCRRR_EA_D_L_W_B_E_X_PT.PPF," where:
  - YYYY = year
  - MM = month, leading zero
  - DD = day of month, leading zero
  - TT = district, leading zero
  - CCC = county, 2- or 3-letter abbreviation as shown in section 1–1.08
  - RRR = route number, no leading zeroes
  - EA = contract number, excluding the district identification number, expressed as 6 characters
  - D = traffic direction, *NB*, *SB*, *WB*, or *EB*
  - L = lane number from left to right in the direction of travel
  - W = wheel path, *L* for left, *R* for right, or *B* for both
  - B = beginning station to the nearest foot, such as 10+20, or beginning post mile to the nearest hundredth, such as 25.06, no leading zero
  - E = ending station to the nearest foot, such as 14+20, or ending post mile to the nearest hundredth, such as 28.06, no leading zero
  - X = profile operation, *EXIST* for existing pavement, *INTER* for after prepaving smoothness correction, *PAVE* for after paving, and *CORR* for after final surface pavement correction
  - PT = type of HMA or concrete pavement, such as Type A HMA, RHMA–G, JPCP, or CRCP
- Provide profile data in an unfiltered electronic pavement profile file format (.PPF).

Appendix I: Sample Quantity Plan Sheet



SEGMENT CORRECTIONS AND DIGOUTS

ROUTE	LINE DESIGNATION	LOCATION BEGIN PM (Sta)	LOCATION END PM (Sta)	LENGTH (N) (mi)	SEGMENT CORRECTION NB DIRECTION LN #1 (EA)	SEGMENT CORRECTION NB DIRECTION LN #2 (EA)	SEGMENT CORRECTION SB DIRECTION LN #1 (EA)	SEGMENT CORRECTION SB DIRECTION LN #2 (EA)	REPLACE ASPHALT CONCRETE SURFACE NB DIRECTION LN #1 (CY)	REPLACE ASPHALT CONCRETE SURFACE NB DIRECTION LN #2 (CY)	REPLACE ASPHALT CONCRETE SURFACE SB DIRECTION LN #1 (CY)	REPLACE ASPHALT CONCRETE SURFACE SB DIRECTION LN #2 (CY)	COMMENTS
XXX	"A"	2112.00 (Sta)	2640.00 (Sta)	0.1		1	1			11.4			Digout & Segment Correction Before Paving
		7920.00 (Sta)	8448.00 (Sta)	0.1	1			1					Segment Correction Before Paving
		11616.00 (Sta)	12144.00 (Sta)	0.1	1		1				22.5		Digout & Segment Correction Before Paving
		32736.00 (Sta)	33264.00 (Sta)	0.1			1	1					Segment Correction Before Paving
				TOTAL		8				33.9			

(N) = NOT A SEPARATE PAY ITEM, FOR INFORMATION ONLY
EXACT CORRECTION LOCATIONS TO BE DETERMINED BY THE ENGINEER

SEMI PERMANENT REFERENCE POINT (N)

DESCRIPTION	COORDINATES NORTHING	COORDINATES EASTING
Beg-NB-XX+XX-Inc	xx,xxx,xxx	xx,xxx,xxx
End-NB-XX+XX-Inc	xx,xxx,xxx	xx,xxx,xxx
Beg-SB-XX+XX-Dec	xx,xxx,xxx	xx,xxx,xxx
END-SB-XX+XX-Dec	xx,xxx,xxx	xx,xxx,xxx

SUMMARY OF QUANTITIES
Q-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans
REVISED BY
DATE REVISED
CALCULATED/DESIGNED BY
DRAWN BY
CHECKED BY
FUNCTIONAL SUPERVISOR
BORDER LAST REVISED 7/2/2010
UNIT 0000
PROJECT NUMBER & PHASE 0000000001

Figure I-1: Sample Quantity Plan Sheet

Appendix J: Performing Verification Tests on Inertial Profilers

Performing the 3 verification tests, which are bounce test, block test, and distance measuring instrument test.

Figure J-1: Demonstration on How to Perform a Bounce Test

Bounce tests are performed by positioning the host vehicle on a flat and level surface, with the test plate directly beneath the profiler. Power the system and check that the profiler, mounted to the undercarriage of the pickup just behind the passenger door, has reached operational stability as specified by the manufacturer. Follow the manufacturer's recommended procedure for performing the bounce test. The static portion must result in an International Roughness Index (IRI) of less than 3 inches per mile and the bounce portion must result in an IRI less than 8 inches per mile.

The vertical displacement will be measured from flat plates centered on the ground beneath the height sensors. Performed over a simulated distance of 528 feet, a vertical displacement (bounce) of the vehicle of 1-2 inches will be performed.

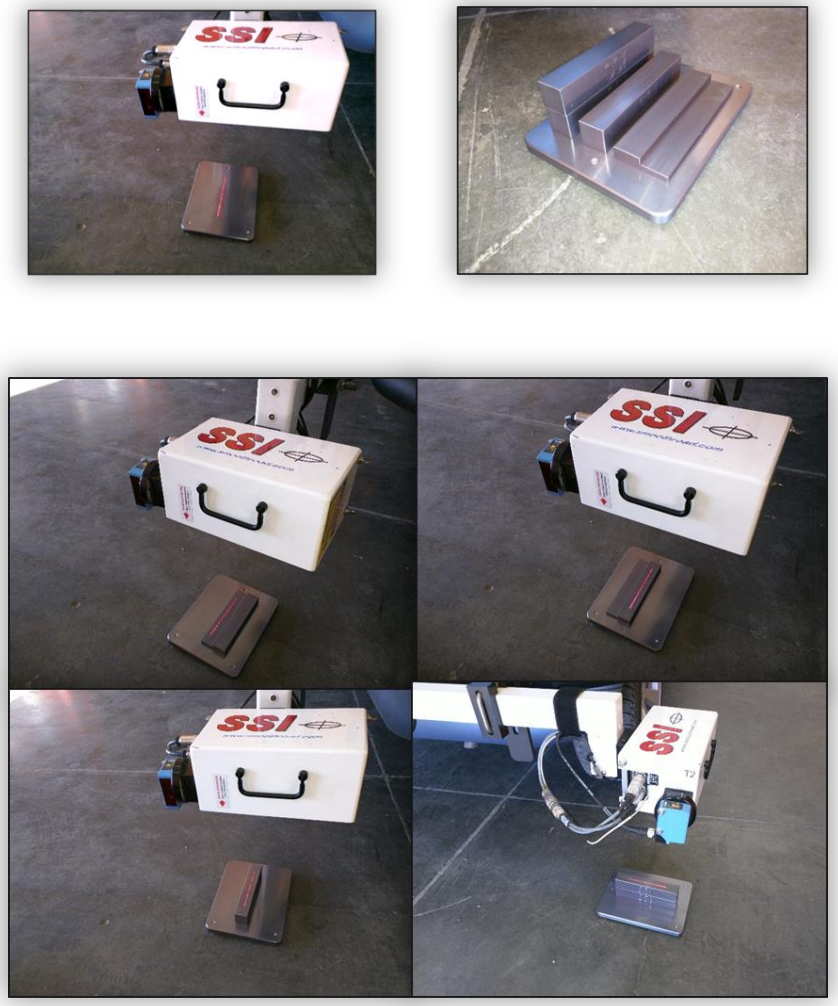


Figure J-2: Block Test (Vertical Verification of Calibration)

Block sensor check tests are run after the profiler has reached operational stability as defined and specified by the manufacturer. This test will be conducted with the inertial profiler on a flat and level area. Its purpose is to check the height measurements, in inches, from the height sensors of the test vehicle using blocks of known heights. During the test, do not lean on the profiler or cause it to move in any way. Under windy conditions, it may be necessary to perform this test indoors. The test procedure consists of the following steps:

1. Center the smooth base plate under the height sensor of the profiler and allow the system to take height measurements. Zero out the sensors.
2. Center a 0.25-inch block below the height sensor and on top of the base plate. Record the height measurement.
3. Replace the 0.25-inch block from the base plate with a 0.50-inch block. Record the height measurement.
4. Replace the 0.50-inch block with a 1.00-inch block and record the height measurement.

5. Finally, replace the 1.00-inch block with a 2.00-inch block and record the height measurement.

Each inertial profiler must be furnished with a dedicated base plate and gauge blocks. The operator of the profiler will tabulate the gauge block measurements and record them in a calibration log. Determine the difference between each measurement on a gauge block and the base plate to get the thickness of the gauge block as measured by the height sensor. Repeat this calculation for each gauge block. Determine the absolute values of the differences between the computed thickness and the known average block thickness. The absolute differences should be less than or equal to 0.01 inch for each gauge block.

Figure J-3: Distance Measuring Instrument (DMI) Test

Distance Measurement Index Tests test the accuracy of the DMI on one of the test sections:

- Distance Measurement Index Test Section—The test section must be the same test section used for the ten runs performed for repeatability and accuracy. The starting and ending points of the test section will be measured to 528 feet plus or minus 0.1 feet and clearly marked.
- Three automatically triggered runs of the candidate inertial profiler must be made on the designated length of pavement in the prescribed direction of measurement. At the end of each run, record the reading from the profiler's DMI.
- Distance Measurement Index Accuracy—Compute the absolute difference between the DMI readings and the known distance of the path tested for each run. The average of the absolute differences must be 1.0 foot or less to pass the test.

Appendix K: Frequently Asked Questions

Frequently Asked Questions (FAQs) for Section 36-3, "Pavement Smoothness," of the *Standard Specifications*

1. **Why does the inertial profiler operator and equipment need to be certified? How long is the certification valid?**

   Certification of both the inertial profiler equipment and operator assures the integrity of the smoothness data. The equipment is calibrated using California Test 387, "Method of Test for Operation, Calibration and Operator Certification of Inertial Profilers," and American Association of State Highway and Transportation Officials (AASHTO) procedures. The operator is tested on knowledge of the equipment, test methods, and driving ability. The certification is valid for 12 months from the date of testing for both equipment and operator. The inertial profiler equipment must display a current certification decal showing expiration date. Similarly, operators are provided a card showing the make and model they are certified to operate and the expiration date of the certification.

2. **At what stage of construction does the contractor collect smoothness data?**

   This depends on the scope of the project. Typically, the contractor collects hot mix asphalt (HMA) smoothness data at the following stages: Existing (EXIST), after structural section repairs, or surface corrections (BASELINE), just before paving (PAVE), after paving, and after corrections (FINAL).

   For grinding existing concrete, EXIST; after structural section repairs or surface corrections, BASELINE; and after grinding to meet the greater of 60 MRI or 60 percent of existing MRI, FINAL. BASELINE is for information purposes only.

   From new concrete pavement, after paving, and after corrections (FINAL).

3. **Can I use the inertial profiler to collect smoothness data on ramps?**

   Yes, but the length of ramp must be greater than 1,000 feet. The inertial profilers collect data only when they have attained a minimum speed. A ramp has a termination point, but the inertial profiler needs sufficient time and distance to reach the minimum speed. For ramps and traffic lanes less than 1,000 feet, it won't be possible to collect smoothness data for the majority of the distance. A straightedge must be used for shorter lengths.

4. **Why is the contractor required to conduct calibration and verification tests each day before profiling? Aren't they already certified?**

   Equipment is certified once per year. This doesn't guarantee that the equipment is in working order once it arrives on the job site. The inertial profiler consists of complicated machinery. If there is any equipment failure or calibration issues, the smoothness data

will not be accurate. To eliminate possibilities of inaccurate data, the profiler must be calibrated and verified each day before profiling.

5. **Is Caltrans required to conduct calibration and verification tests of their own inertial profiler each day for quality assurance testing?**

   Yes.

6. **How does the contractor submit the smoothness data to Caltrans?**

   The contractor must submit the smoothness data to Caltrans' secure file sharing system and the resident engineer.

FAQ for Section 39-2, Hot Mix Asphalt," of the *Standard Specifications*

1. How are supplemental funds calculated for incentives?

The following formulas will be used to calculate supplemental funds for incentives:

- Supplemental funds for total HMA thickness ≥ 0.3 feet, exclusive of OGFC and HMA leveling courses and structural section repairs = 1.00 x $9,000 x lane miles
- Supplemental funds for total HMA thickness < 0.3 feet, exclusive of OGFC and HMA leveling courses and structural section repairs = 1.00 x $4,500 x lane miles

2. What is a baseline smoothness profile?

A baseline smoothness profile identifies the pay adjustment tables to be used for each 0.1-mile MRI segment. If prepaving corrections, structural section repairs, or both, are proposed before paving, the baseline smoothness profile is measured after corrections or repairs have been completed. If there are no proposed prepaving corrections or structural section repairs, the baseline smoothness profile will be the existing surface.

3. What is a smoothness opportunity?

There are operations during construction that provide an opportunity to improve smoothness. These operations include:

- Each lift of pavement overlay
- Micro milling or cold planing not in the same shift as the paving
- Segment correction

4. Is a prepaving correction considered an opportunity?

Yes, segment correction is considered a paving opportunity.

5. What are prepaving corrections? When should prepaving corrections be done?

When the existing surface has high MRI and ALR values, there is a good chance that any proposed paving over these areas will not result in a smooth riding surface. In such cases, the designer should consider prepaving corrections. The type of prepaving correction is based on the existing pavement distress. The following list includes types of prepaving corrections:

- Segment corrections, if a bid item for segment correction number of 0.1-mi sections is shown on the Bid Item List.
- Mill and fill operations, such as cold planing and placing HMA. When the district uses Section 39-3.04A, of the *Standard Special Provisions*, and allows a cold planed surface to be open to traffic after no more than 7 days, the cold planing is counted as an additional opportunity for improvement.
- Removing and replacing an entire lane.
- Dig outs of the wheel path or entire lane width.
- Pothole repairs.
- Placing a leveling course.
- Cold planing isolated locations.

6. What is an MRI_{SEG}?

The MRI value per segment of 0.1 mile of roadway lane is used for acceptance of work.

7. **What is an incentive and disincentive table?**

   An incentive and disincentive table determines the positive and negative pay adjustments based on the MRI_{SEG} value and indicates whether corrective actions of the pavement surface are required.

8. **What is a mandatory correction? Can corrective actions performed for a mandatory correction result in an incentive?**

   A mandatory correction is required when the MRI_{SEG} value exceeds the maximum allowable MRI. A mandatory correction cannot result in an incentive any greater than would have been provided by the uncorrected surface.

9. **What is an optional correction? Can corrective actions performed for an optional correction result in an incentive?**

   An optional correction is a provision for a contractor to choose either to correct at no cost to Caltrans or not to correct the pavement surface and accept a deduction in payment. By choosing optional corrective action, the negative pay adjustment may be reduced and the contractor may receive full pay. But a contractor will not receive any incentive for an optional correction.

10. **Is an incentive allowed after corrective grinding of paved surface?**

    On HMA pavement, yes, but no greater than the incentive earned by the uncorrected surface. On concrete pavement, yes, and it can be greater than the incentive earned by the uncorrected surface.

11. **What corrective actions can the contractor perform when correcting the paved surface?**

    Corrective actions can be performed by diamond grinding within the specified tolerance or remove and replace the pavement.

12. **What is the thickness limitation for smoothness correction by grinding?**

    Corrective grinding must not reduce pavement thickness more than allowed in section 39-2.01C(16), “Smoothness Corrections,” of the *Standard Specifications*.

13. **What is a target MRI?**

    A target MRI (MRI_T) is used to determine payment adjustment from a pay ranges table for a segment. MRI_T is calculated by a formula for each opportunity using the MRI_0 value. The MRI_0 is the lower of the EXIST or BASELINE MRI values, except when segment corrections are used, then MRI_0 is the EXIST MRI.

14. **What are ALR and ALR_{MAX}?**

    Areas of localized roughness (ALR) are the locations of individual localized roughness that deviate from the acceptable roughness of IRI. ALR_{MAX} is a value of allowable localized roughness limits for a 0.1-mile segment. ALR_{MAX} is the greater value of 160 in/mi or calculated value using the following equation: $ALR_{MAX} = 2.1 \times MRI_T$.

15. **Is the contractor eligible for an incentive on an OGFC surface if it is placed as part of new construction or over paving on the same project?**

No. However, a disincentive can be taken where the new OGFC has a higher MRI than the new HMA it was placed over.

16. Is the contractor eligible for an incentive on an OGFC surface if it's placed on an existing surface or milled surface?

Yes. It is treated much the same as the other types of HMA, except the contractor can only correct ALR, and there is no limit to the final MRI value or the amount of disincentive.

17. Can OGFC surface be ground to improve the MRI value?

No. There are no mandatory correction MRI values for OGFC; however, there are mandatory correction levels for ALR. OGFC may only be ground to meet the ALR threshold.

ProVAL FAQs

1. **What is ProVAL?**

   ProVAL (Profile Viewing and Analysis) is an engineering software application developed for the Federal Highway Administration (FHWA) and the Long-Term Pavement Performance Program. It is used to view and analyze pavement smoothness profiles.

2. **Where can I find ProVAL? How much does it cost?**

   ProVAL is freeware and can be downloaded from the following federal government sponsored website:

   http://www.roadprofile.com/

3. **Is ProVAL training or support available?**

   There are many resources for ProVAL users. Support is available on the ProVAL users website. Training is available from FHWA and Caltrans.

   There are also Caltrans video tutorials that provide ProVAL training. The video tutorials are available at:

   https://dot.ca.gov/programs/construction/pavement-smoothness

   What is Mean Roughness Index

   The average of the IRI measures from the left and right wheel paths for the same lane. Caltrans requires the Mean Roughness Index (MRI) be measured at each 0.1-mile interval.

4. **What are Areas of Localized Roughness**

   Areas of Localized Roughness (ALR) are isolated areas of roughness, which by themselves can cause an increase in the overall reported smoothness index. ALR is calculated as the average of the IRI values over 25 feet of wheel path and reported at the center of the 25 feet. ALR values reported within 12.5 feet of a leave-out are affected by roughness within the leave-out and thus are not typically reported.

5. **How do I use ProVAL to exclude portions of the profile?**

   When excluding a portion from analysis, ProVAL has a “Leave Out” feature. This feature allows the user to designate locations to be excluded from analysis.

6. **How do I calculate MRI and ALR?**

   There are specific training modules that describe the steps to calculate MRI and ALR. The training modules may be found at the link provided in Question 3 of the ProVAL FAQs. Also see Appendix F, “Pay Adjustment Example,” of this manual for a step-by-step process to use ProVAL and a spreadsheet to calculate the applicable payment adjustment for smoothness.

7. **Can ProVAL simulate pavement grinding?**

   Yes. ProVAL’s Smoothness Assurance Module simulates a fixed frame (18-foot, 25-foot, or custom wheelbase) diamond grinder. Please see the ProVAL software manual for the specific grinder. Training videos on using ProVAL to develop corrective grind plans are available at:

https://dot.ca.gov/programs/construction/training/proval-training-videos/10-grind-plan-methods

8. **Can ProVAL simulate a cold planer? Micro milling machine?**

   No. ProVAL can only simulate a fixed-frame diamond grinder. It cannot simulate any other type of grinding machinery.

Appendix L: Resident Engineer Submittal Review Checklists

Table L-1: QC Plan Submittal Review Checklist

☐	**1. Contacts name and phone numbers of those responsible for monitoring smoothness**
☐	**2. Inertial profiler certifications**
☐	**3. Operator certifications**
☐	**4. Manufacturer instructions for test procedures and verification**
☐	**5. Schedule: Methods and timing used for monitoring, testing ride quality, or both, throughout the placement process**
☐	**6. Begin and End semipermanent reference points established in accordance with the plans. Label used in the field in the format of XXXX-D-L-VAL. For example:** • **Beg-NB-1-861+69.60-INC, End-NB-1214+21.10-INC, where DMI stationing increases in the northbound direction** • **Beg-SB-1214+21.10-DEC, END-SB-861+69.60-DEC, where DMI stationing decreases in the southbound direction**
☐	**7. A KMZ file for Beg and End semipermanent reference points (SPRP)**
☐	**8. A listing of GPS coordinates of all SPRP for Beg and End and known leave-outs**
☐	**9. Color photographs clearly displaying the label used to define the Beg and End SPRP**

Table L-2: Checklist for Receipt of Contactor Inertial Profile Runs, Videos or Photos Every 52.8 feet and Summary PDF Reports

PROFILE	Type A, RHMA-G, or BWC	OGFC on Existing Pavement	OGFC on New HMA	New Concrete Pavement	Grind Existing Concrete Pavement
Exist PPF	☐	☐	☐	☐	☐
Exist Video or Photos	☐	☐	☐	☐	☐
Exist Summary Report	☐	☐	☐	☐	☐
Baseline PPF	☐	☐	☐	☐	☐
Baseline Video or Photos	☐	☐	☐	☐	☐
Baseline Summary Report	☐	☐	☐	☐	☐
Pave PPF	☐	☐	☐	☐	☐
Pave Summary PDF	☐	☐	☐	☐	☐
Final PPF	☐	☐	☐	☐	☐
Final Summary PDF	☐	☐	☐	☐	☐

NOTE: Do not insert contractor's media storage devices into state computers. Place in a sealed envelope and label "Save, do not open."

Table L-3: Checklist for Review Payment Adjustment Request

☐	**1. Review naming convention of the XLSM and PVP. Do they match and are they named in accordance with Section 36-3.01C(6)(b), "ProVAL Project File," of the *Standard Specifications*.**
☐	**2. Perform a cursory review of the ProVAL project file to see that all profiles line up and leave-outs are appropriate.**
☐	**3. Check Column T on the "PayAdj" for misaligned data.**
☐	**4. Review the accuracy of the general input sections on rows 2 through 8 of the "PayAdj" worksheet.**
☐	**5. List layer thickness in cell N7 for HMA only; it's critical for Type A, RHMA-G, and BWC, and information only for OGFC.**
☐	**6. List total opportunities for improvement in cell O7 for HMA only; it's critical for Type A, RHMA-G, and BWS, and information only for OGFC.**
☐	**7. List HMA type and condition in cell R7 for HMA only. For concrete, check concrete pay table selection.**
☐	**8. Review the accuracy of columns C and D to verify that the check box on segments for which full-width segment corrections or partial-width segment corrections are used; for HMA only.**
☐	**9. Where full-width segment corrections are used, verify the opportunities were increased by 1 more than the default value entered in cell O7.**
☐	**10. Validate the exported data directly from the ProVAL project file PVP to verify that the contractor did not manipulate values between the time they exported the data from ProVAL and the time it was imported to the "green" tabbed worksheets.**
☐	**11. Review the values in the "total opportunities for improvement" in column M. These values default to the value entered into cell O7, but can be overridden where necessary.**
☐	**12. Verify that all areas of localized roughness (ALR) are less than 160 inches per mile or ALRmax. The contractor indicates this with a "zero" in column R.**
☐	**13. Verify that the engineer's "Overall MRI" values from verification profiles are within 10 percent of the contractor's.**

Table L-4: Payment and HQ Data Submittal

☐	**1. Issue a change order. Fund using supplemental funds for pavement smoothness incentives or disincentives.**
☐	**2. Make payment adjustments on monthly progress estimates.**
☐	**3. Submit the PVP and XLSM file within 2 weeks of each payment adjustment for:** • **Hot mix asphalt pavement: Asphalt.Smoothness@dot.ca.gov** • **Concrete pavement: Concrete.Smoothness@dot.ca.gov** **Include the following text in the subject line: Smoothness Adjustment, Contract ##_#####4 CO ##, EST ##.**

To download the Resident Engineer Submittal Review Checklists, go to:

https://dot.ca.gov/-/media/dot-media/programs/construction/documents/construction-standards/hma-intelligent-compaction-construction/qc-plan-submittal-review-checklist-a11y.pdf