Section 39-1.35. Use for intelligent compaction pilot projects.

Most pilot projects will be HMA including OGFC that are placed under the method compaction specification 39-3.04.

Use bid item: 390030 Intelligent Compaction Lump Sum

Contact Ebi Fini ebi.fini@dot.ca.gov for use of this pilot specification.

Replace section 39-1.35 with:

39-1.35 INTELLIGENT COMPACTION FOR HOT MIX ASPHALT

39-1.35A General

39-1.35A(1) Summary

1

Section 39-1.35 includes specifications for compaction of HMA using intelligent compaction. Intelligent compaction uses vibratory rollers equipped with measurement devices and a documentation system that automatically records critical compaction parameters in real time during compaction.

2

Use standardized data analysis software Veda. For Veda, go to www.intelligentcompaction.com. Veda utilizes data from the intelligent compaction roller to analyze coverage uniformity, mat temperature, and stiffness values during HMA construction.

3

Use intelligent compaction rollers for breakdown and intermediate compaction. Do not collect intelligent compaction measurement values for stiffness when the compacted HMA layer is 0.15 foot or less.

4. Use if electronic design files are available delete para 5.

Insert CAiCE (kcm), Civil 3D (dwg) or landxml (xml).

The Department furnishes project plan layout files in _______ format.

5. Use if electronic design files are not available delete para 4.

Create project layout files for the intelligent compaction system from the project plans.

39-1.35A(2) Definitions

6

California Coordinate System of 1983 (CCS83): A set of 6 geographic zones or coordinate systems designed for specific regions of the State of California, the boundaries of which follow county lines. CCS83 is based on NAD83. When a project crosses state plane zone boundaries, a single zone will be used for the entire project.

Foot: Unit of measurement equal to U.S. survey foot.

Geodetic Coordinates: A coordinate system to describe a position in longitude, latitude, and altitude above the imaginary ellipsoid surface based on a specific geodetic datum. The NAD83 datum is required for use with CCS83 State Plane Coordinates.

Global Positioning System (GPS): A space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth to determine the location in geodetic coordinates. GPS refers to all GPS-related signals including US GPS, and other Global Navigation Satellite Systems (GNSS). GPS satellite signals are subject to interference from canyons, buildings, trees or even fencing. Not all locations are suitable for GPS techniques, and it is your responsibility to determine if the site conditions are practical for GPS, and to notify the Engineer if they are not.

GPS Base Station: A single ground-based system consisting of a GPS receiver, GPS antenna, and telemetry equipment (typically radio and radio antenna or cellular phone) to provide L1/L2 differential GPS correction signals to other GPS receivers.

GPS Rover: A portable L1/L2 GPS antenna, mount, and receiver with telemetry equipment for Real Time in-situ point measurements.

GPS Correction Service Subscription: A service that can be subscribed to receive differential GPS correction signals for higher accuracy GPS positioning without the need of a GPS Base Station. Signals are normally received via cellular wireless data services. Examples of GPS correction service subscriptions are: Trimble VRS™, Leica Smart RTK™, Topcon TopNet™ or OmniSTAR™.

GPS Site Calibration or Localization: A process to establish a relationship between the observed GPS coordinates and the known grid coordinates.

Grid: A Cartesian system of XY (or North-East) coordinates utilizing the California State Plane Coordinates, known as the California Coordinate System of 1983 (CCS 83).

Network Real Time Kinematic (Network RTK): Network RTK is a system that use multiple bases in real-time to provide high-accuracy GPS positioning within the coverage area that is generally larger than that covered by a single GPS base station.

Real Time Kinematic Global Positioning System (RTK-GPS)**:** Real Time Kinematic Global Positioning System is based on the use of carrier phase measurements of the available GPS signals where a single GPS base station or RTK network provides the corrections in order to achieve centimeter-level accuracy in real time.

Coordinated Universal Time (UTC): A time measurement system commonly referred to as Greenwich Mean Time (GMT) based on a 24-hour time scale from the mean solar time at the Earth's prime meridian (zero degrees longitude) located near Greenwich, England.

39-1.35A(3) Submittals

39-1.35A(3)(a) General

7

Not used

39-1.35A(3)(b) Just-In-Time Training

8

At the time of JMF submittal, submit a list of names participating in the just-in-time training. Identify each participant's name, employer, title, and role in intelligent compaction.

39-1.35A(3)(c) GPS Site Calibration or Localization Report and Check Testing

9

Submit GPS site calibration or localization report and check testing results for intelligent compaction rollers within 1 business day of calibration or check testing.

39-1.35A(3)(d) Data and Software Analysis Results

39-1.35A(3)(d)(i) General

10

Within 1 business day of HMA placement submit:

1. Electronic data from intelligent compaction rollers in file format readable by Veda
2. Hardcopy and Adobe pdf file of the HMA compaction quality control report from data analysis performed using Veda software.
3. Post processed Veda data file type *.icp used for creating the HMA compaction quality control report

11

When a test strip is required submit:

1. Test strip data including:
   1.1. Nuclear gage density per location
   1.2. GPS measured coordinates per location
   1.3. Nuclear gage correlation to core densities
2. All passes compaction curves from Veda
3. All passes correlation analysis report from Veda

39-1.35A(3)(d)(ii) Data

12

Submit intelligent compaction information and data elements using Veda. You may combine roller data for multiple rollers operating in echelon into a section file.

13

Name the intelligent compaction data file using:

YYYYMMDD_TTCCCRRR_D_L_W_B_E_X_PT.PPF_Data

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 zeros
D = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) no leading zero
E = Ending station to the nearest foot (i.e., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) no leading zero
X = HMA layer number, 1, 2 …etc.
PT = Pavement Type (i.e., HMA, RHMA, HMA-O, RHMA-O, RHMA-G, etc.)

14

Use the following header information for each intelligent compaction data file or section:

Item No.	Description
1	Section Title
2	Machine Manufacture
3	Machine Type
4	Machine Model
5	Drum Width (inch)
6	Drum Diameter (inch)
7	Machine Weight (ton)
8	Name index of intelligent compaction measurement values (IC-MV)
9	Unit index for IC-MV
10	Reporting resolution for independent IC-MVs – 90 degrees to the roller moving direction (mm)
11	Reporting resolution for independent IC-MVs – in the roller moving direction (mm)
12	CCS83 Zone
13	Offset to UTC (hrs)
14	Number of IC data points

note:

IC-MV = Intelligent Compaction – Measurement Value

15

Use the following data field names for each intelligent compaction data point:

Item No.	Data Field Name	Example of Data
1	Date Stamp (YYYYMMDD)	20080701
2	Time Stamp (HHMMSS.SS -military format)	090504.00 (9 hr 5 min. 4.00 s.)
3	Longitude (decimal degrees or degrees minutes-seconds)	94.85920403
4	Latitude (decimal degrees or degrees-minutes-seconds)	45.22777335
5	Easting (Foot)	6,096,666.000
6	Northing (Foot)	1,524,166.650
7	Elevation (Foot)	339.9450
8	Roller pass number	2
9	Direction index	1 forward, 2 reverse
10	Roller speed (mph)	2.0
11	Vibration on	1 for yes, 2 for no
12	Frequency (vpm)	3500.0
13	Amplitude (inch)	0.0236
14	Surface temperature (ºF)	270
15	Intelligent compaction measurement values	20.0

16

Provide either items 3 and 4 or items 5 and 6. The GPS coordinate for each intelligent compaction data point recorded in data files must be at the center of the front drum.

17

The size of data mesh after post processing must be less than 1.5 feet by 1.5 feet in the X and Y directions.

39-1.35A(3)(d)(iii) Software Analysis Results

18

Analyze the intelligent compaction data daily using Veda include target values for passes, HMA temperature, and intelligent compaction measurement values for stiffness. For fixed interval report use interval length of 100 foot.

19

For each day of production, prepare a HMA compaction quality control report that includes:

1. Final coverage histogram
2. Final coverage fixed interval report
3. All passes histogram
4. Color layout plots of:
   - 4.1. Roller passes
   - 4.2. HMA temperature for initial roller coverage
   - 4.3. HMA temperature final intermediate coverage
   - 4.4. When required intelligent compaction measurement value final coverage

20

Plots must be scaled to be legible and may be 11 by 17 inches.

21

Name the post processed Veda data file using:

YYYYMMDD_TTCCCRRR_D_L_W_B_E_X_PT.PPF_Veda

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 zeros
D = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) no leading zero
E = Ending station to the nearest foot (i.e., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) no leading zero
X = HMA layer number, 1, 2 …etc.
PT = Pavement Type (i.e., HMA, RHMA, HMA-O, RHMA-O, RHMA-G, etc.)

39-1.35A(4) Quality Control and Assurance

39-1.35A(4)(a) General

22

Not Used

39-1.35A(4)(b) Technical Representative

23

A technical representative from the roller manufacturer must be on site during the initial setup and verification testing of the intelligent compaction rollers and first 2 days of production. If requested, the roller representative must assist the Engineer with data management using Veda including intelligent compaction data input and processing.

39-1.35A(4)(c) Just-in-Time Training

24. Edit the number of state personnel if necessary.

Provide just-in-time training onsite or near the project site for your personnel and State project personnel related intelligent compaction. Schedule the just-in-time training with the Engineer at a mutually agreed time and place. Provide training materials for 4 state personnel. Arrangements must be provided that includes an enclosed facility with electrical availability for visual presentations.

25

The training should be 4 to 8 hours in duration and include the following topics:

1. Background information for the specific intelligent compaction system to be used
2. Setup and checks for intelligent compaction system including:
   - 2.1. GPS receiver
   - 2.2. GPS base-station
   - 2.3. GPS rovers
   - 2.4. Rollers.
3. Operation of the intelligent compaction system on the rollers:
   - 3.1. Setup data collection
   - 3.2. Start/stop of data recording
   - 3.3. On-board display options
4. Transferring raw intelligent compaction data from the rollers via USB connections
5. Operation of vendor's software to open and view raw intelligent compaction data files and exporting all- passes and proofing data files in Veda-compatible format
6. Operation of Veda software to import the above exported all-passes and proofing data files, inspection of intelligent compaction maps, input point test data, perform statistics analysis, and produce reports for project requirements
7. Coverage uniformity requirements
8. When test strip is required, method for establishing target intelligent compaction measurement value for stiffness.

26

The following personnel must attend the just-in-time training:

1. Project Manager
2. Superintendent
3. Technical representative for intelligent compaction rollers
4. Intelligent Compaction Quality Control Technicians
5. Roller Operators
5. HMA paving foreman

39-1.35A(4)(d) Quality Control

27

Intelligent compaction provides quality control for Method compaction under section 39-3 by monitoring:

1. Number of roller passes
2. HMA temperature for first coverage of breakdown
3. HMA temperature at the completion of breakdown and intermediate compaction

When HMA thickness is greater than 0.15 foot, intelligent compaction provides the quality control method for measurement values for stiffness, which is correlated to the specified HMA target density.

28

Data collected for intelligent compaction measurement values for HMA stiffness are report only and are not used for compaction acceptance.

30-1.35(4)(d)(i) Test Strip

29

If the HMA layer thickness is greater than 0.15 foot, on the first day of placement of each layer of HMA construct a test strip at least 600 feet long to determine the compaction curve. The compaction curve must be created by Veda and relate the number of roller passes to intelligent compaction measurement values. Nuclear gages must be correlated with density cores under Part 2 of California Test 375.

30

After each roller pass, use a nuclear gage to estimate the density of the material and a GPS rover to measure the positions of at least 10 locations uniformly spaced throughout the test strip. Record the density reading, the number of roller passes, and GPS coordinates for each location. Continue roller passes and collecting nuclear gage density readings until the density remains constant or decreases.

31

The estimated target density must be the peak of the nuclear gage density readings within the compaction temperature range for the HMA mixture. The target intelligent compaction measurement value is the point when the increase in the intelligent compaction measurement value of the material between passes is less than 5 percent on the compaction curve.

32

Use Veda generated correlation analysis report to establish production target intelligent compaction measurement value for stiffness based on target density (% Gmm) that meets the specified in-place compaction requirements. Correlation analysis report is the linear regression between intelligent compaction measurement value and point test results of density.

39-1.35A(4)(d)(ii) Quality Control Technician

33

During HMA compaction provide a quality control technician to be responsible full time for:

1. GPS site calibration or localization and upload to all GPS receivers
2. GPS check testing for the intelligent compaction rollers and rovers
3. Accuracy verification of the temperature sensor by comparing to a NIST traceable standard. The equipment temperature sensor measurement must be within +/- 3 degrees F of NIST traceable standard.
4. Test section construction to establish target compaction pass counts and target values for the stiffness of the HMA using nuclear gauges, pavement cores, and intelligent compaction rollers
5. Construction operation monitoring of the intelligent compaction rollers
6. Quality control testing for pavement temperature and compaction.
7. Intelligent compaction data back up twice per day
8. Data downloading from rollers at the end of the work shift
9. On a daily basis analyze the data from the intelligent compaction rollers using Veda and produce a daily compaction quality control report

39-1.35B MATERIALS

34

Not Used

39-1.35C CONSTRUCTION

39-1.35C(1) General

35

Before the start of production upload the project plan file into the intelligent compaction data analysis software and depending on the roller manufacture, the on-board intelligent compaction computer.

39-1.35C(2) Equipment

39-1.35C(2)(a) Intelligent Compaction Rollers

36

In addition to requirement of section 39, each intelligent compaction roller must:

1. Be self-propelled double-drum vibratory rollers equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied compaction effort
2. Be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
3. Produce intelligent compaction measurement values that represent the stiffness of the materials based on the vibration of the roller drums and the resulting response from the materials
4. Have mounted GPS receiver, antenna, and telemetry equipment to monitor the drum locations and track the number of passes
5. Include an integrated on-board documentation system capable of displaying real-time color-coded maps of intelligent compaction measurement values including location, number of passes, pavement surface temperatures, speeds, vibration frequencies and amplitudes of drums
6. Have a graphical user interface
7. Have capability of transferring the intelligent compaction data by means of a USB port

37

39-1.35C(2)(b) Global Positioning System

GPS must be real time kinematic using one of the followings:

1. GPS Base station
2. Network real time kinematic(RTK)
3. OminiSTAR

38. Insert the zone number. Caltrans Survey manual:http://www.dot.ca.gov/hq/row/landsurveys/SurveysManual/Manual_TOC.html

GPS devices for this project must be set to the same consistent datum, coordinate system, CCS83 zone, and site calibration or localization. The CCS83 zone must be set to zone no. ____.

39-1.35C(2)(b)(i) Correction Signal Source

39

Provide either a GPS base station correction signal or a GPS correction service subscription. The GPS correction signal must be received by the GPS receivers on the intelligent compaction roller and the rovers during operations with a survey tolerance of not greater than 1.6 inch in both X and Y horizontal directions.

39-1.35C(2)(b)(ii) GPS Site Calibration or Localization and Check Testing

40

At least 2 business days before start of production, perform a GPS site calibration or localization to the survey control points indicated on the Project Control Map in the project plans. Perform a GPS site calibration or localization whenever the GPS base station is moved to a new location.

41

Before the start of daily production and using the same datum, conduct testing for the proper setup of the GPS, intelligent compaction rollers, and the GPS rover:

1. On a location nearby or within the project limits, the GPS base station, if required by the GPS, must be established and the intelligent compaction rollers and the GPS rover must be tied into the same base station
2. Verify that the roller and rover are working properly and that there is a connection with the base station
3. Verify the intelligent compaction roller GPS coordinates by:

3.1. Stopping the intelligent compaction roller at a location
3.2. Marking the location of both ends of the roller drum on the surface with a tee
3.3. Recording the GPS measurements from the IC roller ensuring the distance offsets are applied so that the GPS coordinate is at the center of the front drum
3.3 Moving the intelligent compaction roller from the marked location
3.4. Finding the mid-point of the two marked ends of the roller and mark this location on the surface. This marked location is the theoretical center of the front drum.
3.5. Using the GPS rover to measure GPS coordinates of the marked location and record the GPS measurements.
3.6 Computing the difference between recorded intelligent compaction roller GPS coordinates and GPS rover recorded GPS measured coordinates. The differences of the coordinates in grid must be within 0.5 foot in both the horizontal axes X and Y.

39-1.35C(3) Compacting

42

During HMA compaction, monitor each roller's intelligent compaction graphical user interface display for roller passes and HMA temperature. When HMA layer thickness is greater than 0.15 foot, monitor the interface display for intelligent compaction measurement value.

39-1.35C(3)(i) Roller Coverage, HMA Temperature, and Intelligent Compaction Measurement Value

43

At least 90 percent coverage of the construction area must meet or exceed the number of roller passes specified. When the daily HMA compaction quality control report shows the specified roller passes are not met, take corrective action and notify the Engineer of action taken.

44

When the roller HMA temperature sensor indicates compaction temperatures are below specified temperatures take immediate corrective action.

45

At least 95 percent of the construction area must comply with the specified temperatures. When the daily HMA compaction quality control report indicates less than 95 percent of the construction area is completed after HMA is below the minimum specified temperature, implement corrective action before the next HMA placement day and notify the Engineer.

46

For HMA thickness greater than 0.15 foot, monitor the intelligent compaction measurement value for stiffness against the target value established in the test strip. If intelligent compaction measurement value for stiffness is 10 percent or more below the target stiffness value, verify that HMA compaction complies with density specified requirements with a nuclear gage.

47

When intelligent compaction measurement daily average value for stiffness is 20 percent or more below the target measurement value for stiffness, establish a new target stiffness value using a test strip.

48

For HMA greater than 0.15 foot in layer thickness, when intelligent compaction measurement daily average value for stiffness meets or exceeds the target measurement value for stiffness and density, then the corrective action for number of passes and temperature are not required.

39-1.35D PAYMENT

49

Not used