SECTION XXX-INTELLIGENT COMPACTION

XXX.01 DESCRIPTION

This section describes the requirements for implementing the use of Intelligent Compaction equipment.

XXX.02 MATERIALS

XXX.02.01 Equipment

Provide equipment as specified:

Vendor	Bomag	Sakai	Wirtgen/Hamm	Caterpillar	Trimble
Model	Asphalt Manager	CIS	HCQ	AccuGrade	Trimble retrofit
Model No.	BW190AD-4AM	SW880/SW890	HD+ 90 / HD+ 110 HD+ 120 / HD+ 140	CD54B	CCS900 for asphalt compaction
IC-MV	Evib	CCV	HMV	CMV	CMV
IC-MV Units	MN/m2	Unitless	Unitless	Unitless	Unitless
Documentation	BCM 05 Office	AithonMT-A	HMV	VisionLink	VisionLink
Company Address	Bomag Americas, Inc. 200 Kentville Road Kewanee, Il. 61443	Sakai America, Inc. 90 International Parkway Adairsville, Ga. 30103	Wirtgen America, Inc. 6030 Dana Way Antioch, TN 37013	Caterpillar Customer Interaction Center 501 SW Jefferson Street Peoria, IL 61614 USA	Trimble Navigation Limited 935 Stewart Drive Sunnyvale, California 94085
Contact Information	Chris Connolly (301) 262-5447 Chris.Connolly@bomag.com	Brandon Crockett (800)-323-0535 B-crockett@sakaiamerica.com	Tim Kowalski (615) 501-0600 tkowalski@Wirtgenamerica.com	Bryan Downing (763) 493-7533 Downing_Bryan_J@cat.com	Kevin Garcia (303) 635-8834 kevin_garcia@trimble.com

GPS Requirements: Provide the GPS system (including GPS receivers on IC rollers and hand-held GPS receivers (Rovers)) that makes use of the same reference system that can be a ground-based base station or network-RTK, to achieve RTK-GPS accuracy.

XXX.02.01.01 Intelligent Compaction Equipment Requirements

Provide equipment as specified:

1. Intelligent Compaction rollers shall 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. The output from the roller is designated as the Intelligent Compaction Measurement Value (IC-MV) which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials.
3. IC rollers shall be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
4. GPS radio and receiver units shall be mounted on each IC roller to monitor the drum locations and track the number of passes of the rollers.
5. The IC rollers shall include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of IC measurement values including the stiffness response values, location of roller, number of roller passes, pavement surface temperatures, roller speeds, vibration frequencies and amplitudes of roller drums.
6. The display unit shall be capable of transferring the data by means of a USB port.
7. An on-board printer capable of the printing the identity of the roller, the date of measurements, construction area being mapped, percentage of the construction area mapped, target IC-MV, and areas not meeting the IC-MV target values.
8. **Data Analysis Software**. Standardized data analysis software (Veda) is available on the website www.intelligentcompaction.com. The software program will utilize the IC-MV data from the IC roller for analysis of coverage, uniformity, and stiffness values during construction operations. As a minimum, the following Essential IC Data Information and IC Data Elements shall be available for post processing

XXX.02.01.02 Global Positioning System Equipment Requirements

1. GPS receivers on IC rollers and hand-held GPS rovers referenced to the same on-ground base station.
2. GPS receivers on IC rollers and hand-held GPS rovers referenced to the same network RTK.
3. All GPS devices for this project shall be set to the same consistent coordinate datum/system no matter whether GPS or Grid data are originally recorded. UTM is recommended.
4. If UTM coordinates are not available, the State Plane Coordinate system can be used and set as (xx) for this project. *(NJDOT to fill in the appropriate State Plane designation)* Ad-hoc local coordinate systems is not be allowed.

5. Time: the time stamp shall be in military format, hhmmss.ss in either UTC or local time zone. 0.01 second is required to differentiate sequence of IC data points during post process.
6. GPS: Latitudes and longitude shall be in ddmm.mmmmmmmm or decimal degrees, dd.dddddddd. Longitudes are negative values when measuring westward from the Prime Meridian.
7. Grid: Coordinates shall be in meters with at least 3 digits of significance (0.001m or 1mm).
8. **Post-Process GPS Check.** Follow the vendor-specific instructions to export IC-MV data to Veda-compatible formats. Import the IC roller data in to Veda and enter GPS point measurements from the rover and visually inspect the IC map and point measurements on the Veda display screen for consistency.

XXX.03 CONSTRUCTION

XXX.03.01 Intelligent Compaction Requirements

A. Intelligent Compaction

1. NJDOT Compaction specification will be followed.
2. Meet or exceed the optimal number of roller passes in a minimum coverage of 90% of the individual construction area and meet or exceed the target IC-MV values determined from the test section in a minimum of 70% of the individual construction area. Construction areas not meeting the IC criteria (coverage and/or uniformity) will be investigated by the NJDOT prior to continuing with the paving operations. The IC Construction Operations Criteria does not affect the standard NJDOT acceptance processes for the materials or construction operations.

B. GPS Requirements

1. Provide the GPS system (including GPS receivers on IC rollers and hand-held GPS receivers (Rovers)) that makes use of the same reference system that can be a ground-based base station or network-RTK

XXX.04 QUALITY CONTROL PLAN

XXX.04.01 Quality Control Plan Requirements

Prepare and submit a written Quality Control Plan (QCP) for the project. As a minimum, the QCP shall contain the following information:

1. Contract-specific, state how to control the materials, equipment, and construction operations including subcontractors and suppliers as well as production facilities and transportation modes to the project for the asphalt mixture operations.
2. Include an organizational chart showing all quality control personnel and how these personnel integrate with other management/production and construction functions and personnel.
3. Quality Control Technician (QCT). The person(s) responsible for conducting quality control and inspection activities to implement the QCP. There may be more than one QCT on a project.
4. IC Roller Operator(s). The person responsible for operating the IC roller(s) and attached IC equipment. Sufficient training for the roller operator(s) shall be supplied by a representative of the manufacturer of the equipment.
5. IC Equipment. The roller supplier, make, roller model, number of IC rollers to be provided, and the GPS system supplier to be utilized.
6. Temperature Controls: provide details on their plans to achieve minimum mat temperatures during compaction. IC roller compaction process needs to be completed (final IC roller pass) before the mat temperature fall below a minimum of 240^{O} F (115^{O} C) for the initial phase (breakdown) and 200^{O} F (93^{O} C) for the intermediate phase.

XXX.04.01.01 Quality Control Requirements

1. Provide daily GPS check testing for the IC roller(s) and rover(s).
2. Provide test section construction to establish target compaction pass counts and target values for the strength of the materials using the standard testing devices; i.e., Nondestructive density gauges, pavement cores, and IC roller(s).
3. Monitoring of the construction operations and the IC roller(s) during production and final evaluation operations.
4. Quality control testing to monitor the pavement temperature and the required level of compaction.
5. Daily download and analysis of the IC data from the roller(s).
6. Daily set-up, take down and secure storage of GPS and IC roller components

XXX.04.01.02 Quality Control Testing Requirements

XXX.04.01.02.01 Materials Sampling and Testing

1. Temperature. The procedure for monitoring the temperature of the materials during production, transportation, laydown and compaction operations. A minimum frequency shall be one test for two hours of placement and shall include all steps in the process.
2. Density/Compaction. Identification of the standard testing device(s) and frequency for measuring the in-place density of the asphalt mixture. The minimum frequency of tests shall be one test for each 250 tons of asphalt mixture placed.
3. IC Roller Data. The procedure for obtaining the IC roller data. The minimum frequency of obtaining the data from the roller shall be two (2) times per day of asphalt compaction operations. The data is date/time stamped which permits for external evaluation at a later

time. Data from the on-board printer if required shall be given to the Engineer when requested.

XXX.04.01.02.02 GPS Check Testing

1. On a location nearby or within the project limits, establish the GPS base station (if required by the GPS), the IC roller and the GPS rover are tied into the same base station.
2. Verification that the roller and rover are working properly and that there is a connection with the base station.
3. There are two options for comparing the roller and rover coordinates. Production shall not begin until proper GPS verification has been obtained. IC vendors' recommended verification process can be used to augment either of the following options:
    a. Conduct a GPS measurement while the IC roller is stationary. The GPS coordinated from the roller on-board display shall be recorded ensuring that the distance offsets are applied to the center of the front drum (e.g., the measurement is at the roller GPS receiver position). Place the hand-held GPS receiver on top of the GPS receiver mounted on the IC roller and record the coordinates from the hand-held receiver display. The differences of the coordinates between the IC roller GPS receiver and hand-held GPS receiver shall be within 2 inches (50 mm) in both the horizontal axes (X and Y). The check for the vertical axis is not required.
    b. A location shall be marked on ground. Move the IC roller so that the center of the front drum is on top of the marked location. Record 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. Move the IC roller from the marked location and use a hand-held rover to measure at the marked location. The differences of the coordinates in grid shall be within 6 inches (150 mm) in both the horizontal axes (X and Y). On some IC systems, distance offsets are applied to the roller GPS measurements from the on-board display and the coordinates may be on the left or right side of the drum. In those cases move the IC roller so that the left or right side of the front drum axle is flushed with the marked location. Place the hand-held rover right on the marked location and check the difference of both coordinate records. The final GPS coordinate for each IC data point recorded in data files need to be at the center of the front drum.
4. Upload the project plan file into the IC Data analysis software and depending on the roller manufacture, the on-board IC computer.
5. GPS check testing shall be conducted daily during production operations to ensure consistency and accuracy of GPS measurements for all GPS devices prior to the paving and compaction operations.

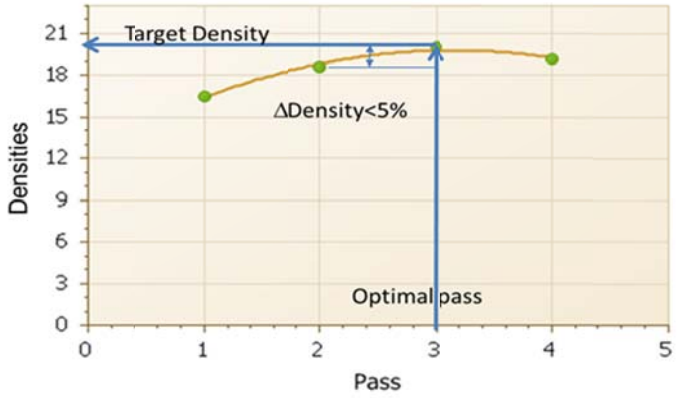
XXX.05 TESTING PROCEEDURE AND PLANNING

XXX.05.01 TEST SECTIONS

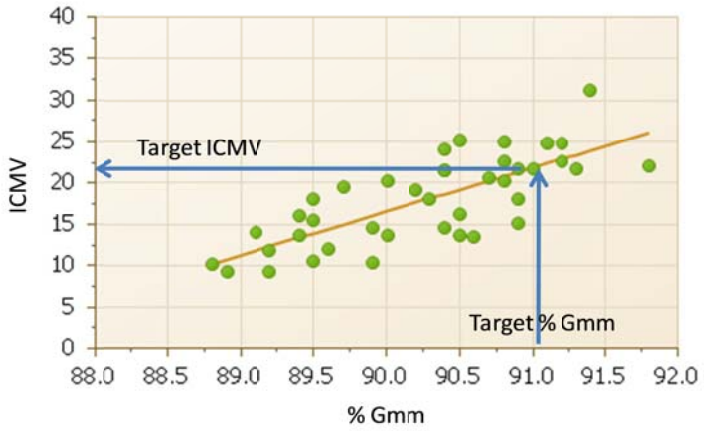
Test section evaluations are intended to verify the mixture volumetric of mixtures and determine a compaction curve of the asphalt mixtures in relationship to number of roller passes and to the stiffness of mixture while meeting the *NJDOT* in-place compaction requirements.

Conduct evaluations every lift and be approximately 300 tons of mainline mixtures. Use the low vibration amplitude and the same settings (speed, frequency) throughout the section in the initial phase. After each roller pass, a nondestructive density device shall be used to estimate the density of the asphalt mixture at five (5) locations uniformly spaced throughout the test section. The density readings and the number of roller passes that takes to achieve the desired compaction will be recorded.

The estimated target density will be the peak of the nondestructive readings within the desired compaction temperature range for the mixture. The IC roller data using the IC data analysis software will create an IC compaction curve for the mixture. The target IC-MV is the point when the increase in the IC-MV of the material between passes is less than 5 percent on the compaction curve. The IC compaction curve is defined as the relationship between the IC-MV and the roller passes. A compaction curve example is as follows:



Linear regression relationships between the point test results and the IC-MV results will be used to establish the production target IC-MV as the target density (% G_{mm}) meets the *NJDOT* in-place compaction requirements. A linear regression curve example is as follow



XXX.06 MEASUREMENT AND PAYMENT

XXX.06.01 METHOD OF MEASUREMENT

This item will not be measured as it will be paid as a lump sum for providing for the Intelligent Compaction for Asphalt Mixtures on the project.

XXX.06.02 BASIS OF PAYMENT

The incorporating of the Intelligent Compaction process will be paid at the contract lump sum price for Intelligent Compaction for Asphalt Mixtures**.**

Payment will be made under:

Pay Item	*Pay Unit*
Intelligent Compaction for Asphalt Mixtures	LS

This item includes all costs related to providing the IC roller(s) including the fuel, roller operator, GPS system, or any other equipment required for the IC process. All quality control procedures including IC rollers and GPS systems representatives support, on-site training and testing facility shall be included in the contract lump sum price.